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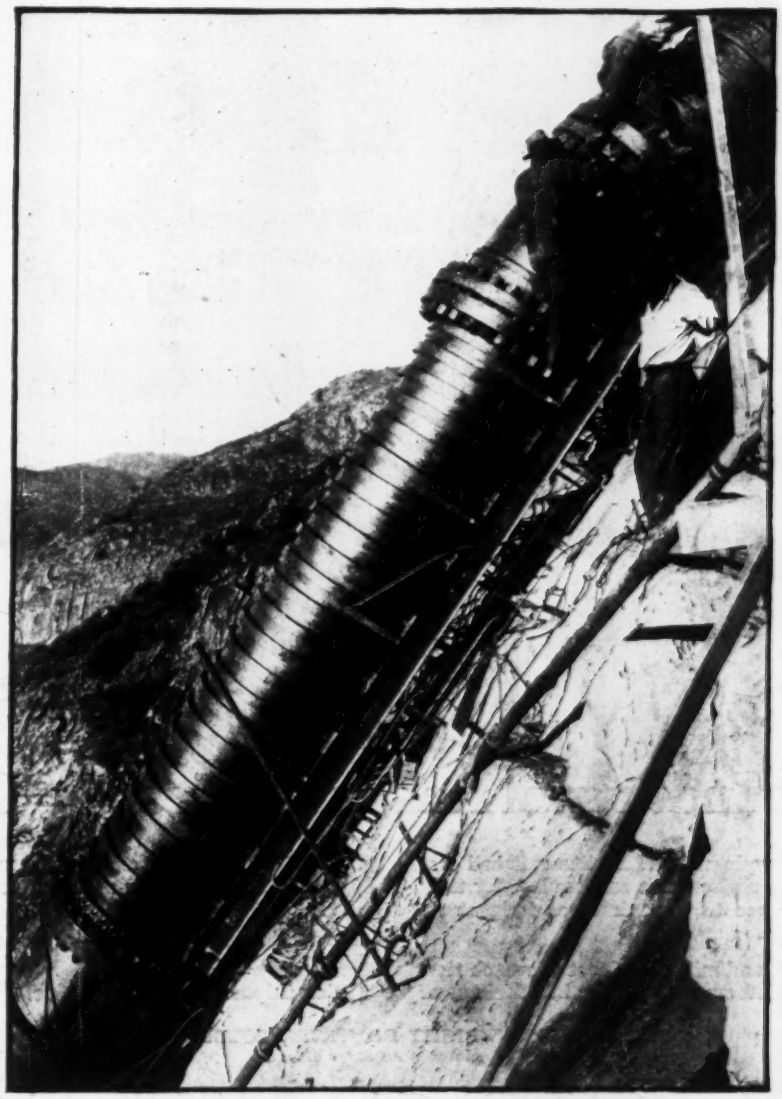


Erecting Penstock on California High Head Hydro-Electric Project

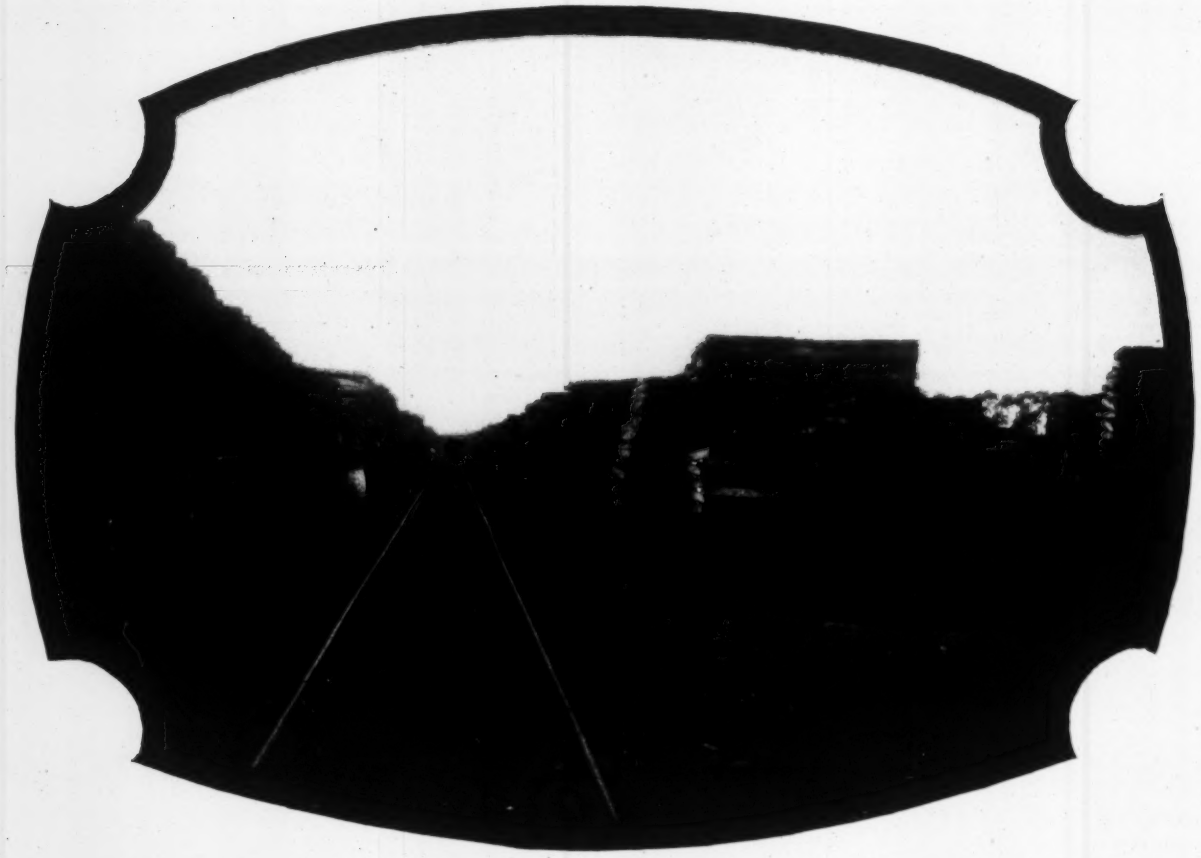
Erecting High-Head Penstock on the Balch Project

Heavy Seas Damage Shore Protection Works at Long Beach

Industrial Railways for Factory and Construction Work-II

Designing Ventilating System for Vehicular Subway in California

KREOLITE



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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

McGraw-Hill Publishing Co., Inc.
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FRANK C. WIGHT
Editor

Volume 98 | NEW YORK, MARCH 10, 1927 | Number 10

Requiescat in Pace

THE Sixty-Ninth Congress has passed into history and few tears will be shed at the passing. It probably did some constructive things, but they are lost in the maze of its astounding inaction. At this writing the records are so confused that no true report of the things done can be given, but enough of engineering interest was before the Congress in its two years life to make a review of them worth while. That review must await the conclusions of the clerks of Congress as to just what was accomplished. Meanwhile the country has some nine months of respite.

Rules Above Right

IF ONE holds to the view that there is too much legislation one can view with complete approval the rules of order that govern the United States Senate. Certainly the display at the closing days of the last session can be approved on no other grounds. With the House of Representatives so organized that there can be no real debate and with the work there completely relegated to committees, there is need that the upper house be allowed ample time for public debate, but the system whereby one senator can not only hold up legitimate business but can completely stop proceedings is unreasonable. Fortunately the United States government still has some credit, and its executive officers know certain processes by which business can be continued without funds, but there is something intrinsically wrong in a system which forces the necessary operations of government to go by the board in a course of a struggle to defeat action on matters of policy or politics. The Senate did not further its defense of its rules by its performance in the first days of March of 1927.

A State Cement Mill to the Bar

MICHIGAN is reaping the first fruits of its experimenting with cement manufacture. In 1921 the state, at the instance of a governor with decided leanings toward government ownership, took over, under lease, the operation of a privately owned cement mill and proceeded to operate it mainly with convict labor and to use the cement for the state's own construction. Considerable sums of money were spent during the period of the lease in revamping the property and in preparing it for convict operation and toward the end of the late governor's term the state contracted to pay around $650,000 for the property and the stocks and supplies in hand. The new governor has now instituted an investigation of the whole procedure. So far this has been one sided with no opportunity for the defenders of state ownership to reply, but the evidence submitted is sufficient to show that the mill was far from modern in equipment, that the private owner had been operating, if not at a loss, with a narrow margin of profit, that the accounting under the state control was obscure, to say the least, and that charges of short weight bags and under-specification cement are at least credible. The lesson is not so much that the state cannot make cement properly and cheaply as it is that it is practically impossible to find out whether it can do so. Always in major commercial operations of this sort there is under-cover work, there is concealment of the true state of affairs and confusion as to economy and security which far offset any expected gains in protection of the state against the supposed improprieties of the private manufacturer. It is much safer, and probably much more economical, for the state to protect its interests by proper purchasing than by attempting the dangerous venture of manufacturing.

Fresh Air for Motor Tubes

ATTENTION is called to the elaborate preparation made for the proper ventilation of the Oakland estuary tube, as described in the article elsewhere in this issue. This automobile tunnel was started subsequent to the Holland tunnels between New York and New Jersey and the ventilating system was planned with the experience gained in the larger Eastern operation. The lay public still seems to be somewhat suspicious of the safety of these tubes. The care taken in the design of their ventilation should relieve engineers, at least, of any such doubts.

Mutable Road Officials

GOVERNORS and legislatures hold curious views concerning their road engineers. In Wisconsin, as we noted somewhat fully a few weeks ago, the governor turned out the state highway engineer John T. Donaghey with less consideration than ought decently to be given an office boy. In South Carolina last week the lower house of the legislature took action to reduce the salaries of the highway commission chairman and the state highway engineer from $6,000 each to $5,000 each and the author of the act candidly stated, according to the press dispatches, that his action was taken because the commissioner was only "an office boy." Incidentally he classed him as a "state house rat" but this we may reasonably assume was merely a blazing fragment thrown off in the violent revolutions of southern oratory, for there was hot debate, it being only fair to state that several legislators vigorously defended the commissioner and state engineer as not being overpaid for directing a road expenditure of some seventeen millions a year. However, the majority vote of the house was for reduction. Then we have an utterance from the Governor of Maryland, Albert E. Ritchie. He recommends that the legislature shall increase the salary of John W. Mackall, highway commissioner and engineer, to $12,500 in recognition of this engineer's "worth to the community." We are not forcibly impressed with any great lesson in these recitals of hap-

penings. Mr. Mackall was lucky enough to receive a deserved compliment from his boss and Mr. Donaghey and Mr. Moorefield were unlucky enough to receive undeserved rebukes from their bosses. Perhaps, however, here is the lesson: It is all a question of luck, as our states now conduct their highway business aggregating one and a third billion dollars a year, how long the directing highway officials hold their jobs and whether they are demoted or promoted.

Nullification Acts

SELDOM is such reactionary legislation proposed as that embodied in two bills now before the New Jersey legislature prohibiting the courts or any other public authorities from action designed to protect the public water supplies of the state from contamination by bathing in them. One of the bills includes fishing and boating also. The effect of the bills would be to nullify all earlier legislation and all common law rights of municipalities, water companies and water consumers which might otherwise be invoked to protect surface water supplies from contamination by the means indicated, except through the acquisition of riparian rights along the streams, reservoirs or lakes from which their supplies are drawn. This would be a long step backward. Taking all such matters out of the jurisdiction of the courts, as the house bill proposes, raises a constitutional question as to the power of the legislature to deprive cities and water consumers of the right of adjudication. The primary object of the bills is to nullify the recent bathing control amendments to the Sanitary Code of New Jersey, enacted recently by the State Board of Health under legislative authority to adopt and amend such a code. The amendment met with strong opposition from representatives of amusement places, bungalow owners and others along various surface sources of public water supply. It seems almost incredible that the legislature will strip hundreds of thousands of citizens of New Jersey of all sanitary protection against indiscriminate multitudinous bathing in their sources of water supply, cutting off recourse to the state boards of health and to the courts.

Discounting Labor Rate Changes

BY ACTION of the highest courts in the state the New York Board of Transportation has been upheld in its insertion of a "prevailing wage" clause in the new contracts for the construction of the city subways. It now remains to be seen how this clause will affect construction. Certainly the bids that are being received on the contracts containing this provision are raised a certain amount to take care of the now unknown but to be expected demands for higher wages on the part of labor, demands which by a friendly interpretation of the "prevailing wage" will be apt to be granted by the board. The courts have apparently assured the legality of such a procedure but they have by no means justified its economy or fairness. It is interesting to note that in considering the enforcement of this "prevailing wage" clause the State Industrial Survey Commission's recent report repeated the suggestion made in an editorial in this journal of Oct. 21, 1926, that a new form of contract might be desirable in which the government would take the risk, or benefit, of labor wage changes during the life of the contract. "If the contractor on public work," says the report "is assured by law that any unforeseen increase in his wage cost due to change in the scale of wages, may be adequately taken care of, it is believed that bidding on public work will be much closer and that contractors will not be obliged to include excessive margins of safety to take care of such increases." It has been contended that such a system would throw too much control of cost into the public body which lets the contract and which, as a political expedient, might be too ready to listen to labor's demands for higher wages. If that is the only objection to the scheme, the opposition is pretty weak. What are the real objections to trying such a form of contract?

The Voracious Ocean

DATA in the article on storm damage to shore protection works at Long Beach on p. 410 make two points clear: foreshore protection when competent engineering is behind it is economical at most any cost; and such works are a real protection to beach property. As to the relative worth of high or low groins, the experience at Long Beach seems to prove nothing; and whether another type would have suffered less damage remains an hypothesis. But this fact appears to have been well demonstrated: that groins connected to bulkheads or run well back of high water lines, held a beach that was otherwise lost with consequent property damage. It is an agreed fact among technicians in foreshore protection that openmindedness toward the type of shore protection works is the best approach to the problem. But it is also agreed that to hold the Long Island and New Jersey beaches intensive foreshore protection, coupled with increasing tidal and current studies is a prime necessity. There has been enough of the practice of groin construction on the part of land development companies who believe anything of timber, piling, rock, or any combination of these materials will afford sufficient protection.

Another Year's Auto Damages

CONNECTICUT comes forward each year with a record of accidents on highways which is of particular interest because it is somewhat more complete than that of most states and is considerably more precise in its analysis of causes. The record for 1926 shows that, compared with 1925, there were more accidents but fewer people killed and therefore more injuries and property damage. The registration has increased from 249,458 in 1925 to 274,782 in 1926. There is no record of car mileages for either year. Some two score—a count is a little indeterminate—causes of accidents are considered. For some of these the line of the graph rises above that of 1925 and for others it dips below; the rise or dip may be the first indication of a trend or it may indicate merely a temporary fluctuation. Recklessness of operators and carelessness of pedestrians and others are responsible for most accidents—roughly 21 out of 24. This is reaffirmation of a widely determined fact in motor vehicle experience and offers no new suggestion. Indeed the whole count and analysis gives an impression of futility in highway accident determination which carries danger of an error in conclusion and thought. The major causes of road accidents being what they are, it is only by popular conviction and education that any hope of remedy exists. Repetition of the counts of the people killed and hurt and of the value of property lost until their cruelty and

wastefulness are impressed on all people, is the first step in educating the road-using public to reform. And let it be remembered that not only Connecticut figures but all figures of highway accidents, show that it is the development of a personal regard for safety and not greater refinement in roads or vehicles or signal systems which makes strongest for safety of travel on public roads.

Beginning Anew in Day Labor

THE Campbell bill, which was intended to legislate governmental day labor construction out of existence, was not brought to vote in the recent session of Congress and therefore is dead for the present. One honestly anxious for better contracting and for better government may regard its demise with mixed feelings, for it combined a wise principle with questionable tactics, and in attempting a general reform imposed specific restrictions which might well have operated against public policy.

The bill, there seems to be little reason to deny, was initiated by the Associated General Contractors, as a part of their campaign against day labor or force account construction of public work. That campaign, whatever anyone may say of its selfish interest, has a sound basis of reason. Just as the electric power interests are against government ownership of power, and the railroad interests against government ownership of railroads, so are the contractors against the government doing its own contracting. That is a perfectly understandable human trait. Indeed, one would have to go far and seek long to find anyone so liberal in his collectivist views as to desire the community to undertake *his* special kind of activity. But the contractors must be given the credit of having more than mere self-advancement at heart. They are close to construction, they know its risks and its necessities, and they, better than any one else, know the evils that flow from the entry of government into their kind of work. They have, too, with them in their views a great number of independent observers who believe that the interests of the people are best served, as a general thing, when public construction is carried out under government direction but by skilled constructors who get a contract to do the work under the spur of competitive bidding.

Having said that much, however, it is fair also to record that the great evil in force-account construction does not lie with the federal government. One branch of the government, the Corps of Engineers, does do a great amount of day labor work, but the amount of such work done by the other branches is negligible. The onus of the charge against the government in this particular, then, had to be against the Corps of Engineers and it was against that body that most of the argument for the evil had to be made. And when those charges came to be detailed it was found that they reduced mainly to two classes of work, the dredging done in and around our harbors, and the control works in the Mississippi. Both of these proved to be fairly strong positions to attack, because for both a tenable defense could be advanced on the ground, in the case of dredging, of the maintenance character of the operations; and in the case of the levees, of the continuing nature of the work plus the necessity of maintaining some government control over a sympathetic and restricted group of contractors.

As the bill was first written, and as it was submitted to the Senate, it absolutely prohibited the doing of any force-account work in amounts over $5,000 except in times of public emergency proclaimed by the president. The House committee, which held extensive hearings on this bill, ameliorated this considerably. The amount was raised to $25,000, but what was more important, the government was not barred from doing its own construction; but was required in every project to prepare plans, make detailed estimates, and ask for bids. It was not definitely ordered to let the work to the lowest responsible bidder, if that bid was reasonable, as it was in the first draft, but was, rather vaguely, permitted to "conduct said construction project by contract or otherwise." Furthermore, the government was ordered to compile "within 60 days after the completion or acceptance of any construction project" (obviously by that wording whether done by contract or day labor) "a statement of the total expense, together with a detailed statement of any change made in the plans and specifications as well as the time of completion on which the original estimate was made."

This revised bill was by no means as drastic as the first draft. It contains a sound theory of check on the possibilities of unbridled extension of federal government construction by its own forces. If the government has first to make a thorough and public study of the possible costs of doing work itself, and then after such work is done has to present fully the actual costs, checked against its own estimate and certain rejected bids, it will walk softly in its adventures into the contracting business. The pitiless light of publicity has great curative powers.

The amended Campbell bill, then, was far from being the radical measure it started out to be. It did not absolutely restrict freedom of action of government engineers confronted with an obstructive contracting situation, a situation which the contractors themselves in their confidential moments will admit sometimes arises. At the same time, it put a curb on unrestrained governmental construction activity, which practically every one admits is a desirable end. But the amended bill suffered from the connotation of its original draft and the opposition that arose, sufficient to prevent its being brought to a vote, was based on the fear that this was but an entering wedge toward complete prohibition of governmental construction and the removal from the government of a very necessary tool, or weapon, as one chooses to interpret it.

The episode has elements of interest. It is a fact, we think, that the major evil in day labor construction does not lie in the federal government, but in the states, counties, and cities. Not inconceivably the contractors may admit this, but probably they would say that the federal government is a shining example, and if day labor could be prohibited by law at Washington, Minneapolis and Lansing might follow suit. There is something to that thought but its success depends upon its succeeding. And now that it has not been able to succeed, might it not be better to try attacking the evil from the bottom up, rather than from the top down? And wherever attacked, would it not be wiser to forego complete prohibition in favor of the more insidious, but probably equally effective, requirement for full estimates, wide advertisement for bids, and public statement of final cost? Any day labor operation that can stand up against this succession of attack is probably justified.

Designing a Ventilation System for a Vehicular Subway in California

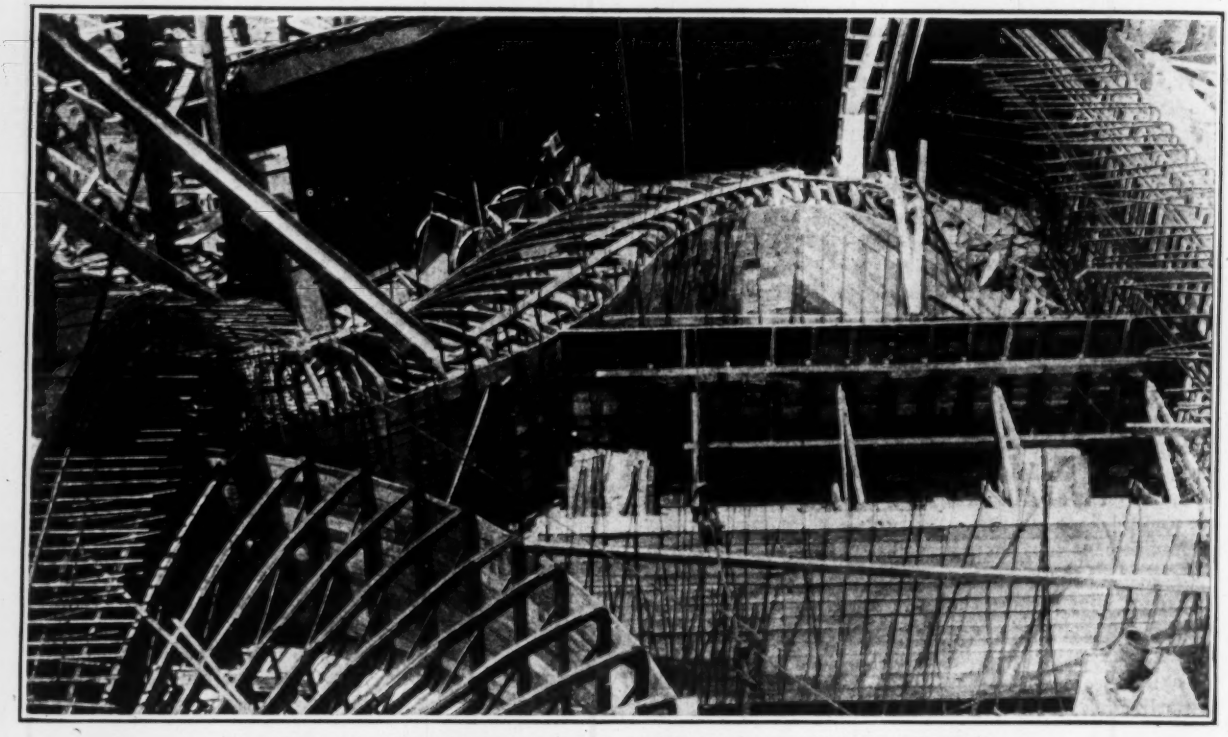
Oakland Estuary Tube Ventilated by Transverse Method—Bulkheads in Air Ducts at Middle Divide Both Supply and Exhaust Systems Into Two Parts—Fans in Portal Structures

By Merton C. Collins
Structural and Ventilating Engineer, Estuary Subway, Oakland, Calif.

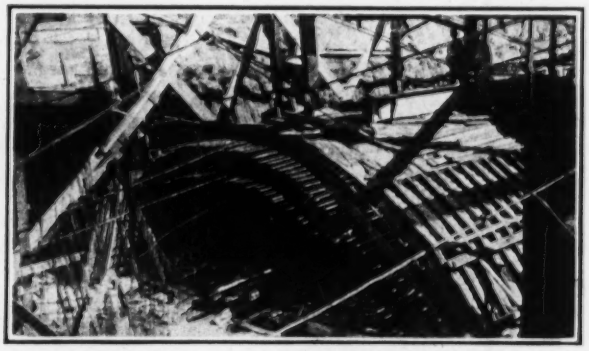
BECAUSE ventilation requirements govern many features of the structural design and even chief features of a subway project as a whole, proper provision for the ventilation of vehicular subways can be made only after much preliminary study. In order to secure an economical structure, therefore, the ventilation design should be concurrent with and closely co-ordinated with the structural design. This is the policy that was followed in working out the ventilation and structural features of the Oakland estuary subway described in the following. An article on general features of design and construction of this project appeared in *Engineering News-Record*, Oct. 28, 1926, p. 692.

The design of the subway was actively commenced in September, 1923, with the author engaged to carry on the ventilation studies and design, and the structural design of the equipment buildings. In beginning work on this project the author was impressed by the fact that, despite the enormous growth of motor vehicle traffic in the United States in recent years, prior to work on the estuary tube scientific methods of ventilation had been applied on only two large vehicular tunnels, or subways, the Holland Tunnel in New York and the Liberty Tunnel in Pittsburgh. In view of the complex traffic problems to be solved in many congested localities, it is highly probable that the number of ventilated vehicular subways will materially increase in the next few years.

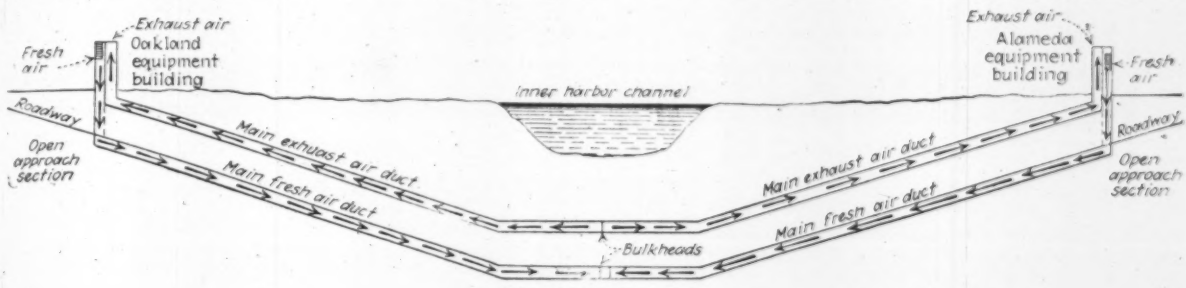
The transverse method of ventilation was adopted for the Oakland estuary subway after natural ventilation and longitudinal ventilation had been considered and rejected. Natural ventilation, such as is used in some European vehicular tunnels, was not found feas-



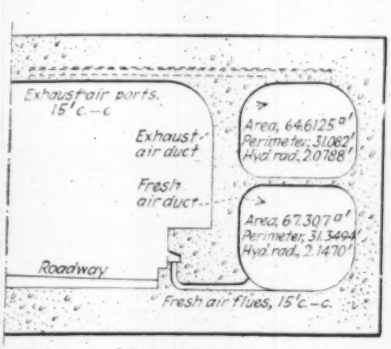
FORMS FOR CURVED VITIATED AIR DUCTS IN TRANSITION STRUCTURE



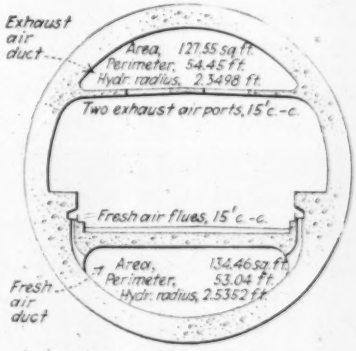
VITIATED AIR DUCTS OVER ROADWAY IN CIRCULAR STRUCTURE



Ventilation Distribution



Typical Half-Section of Rectangular Subway



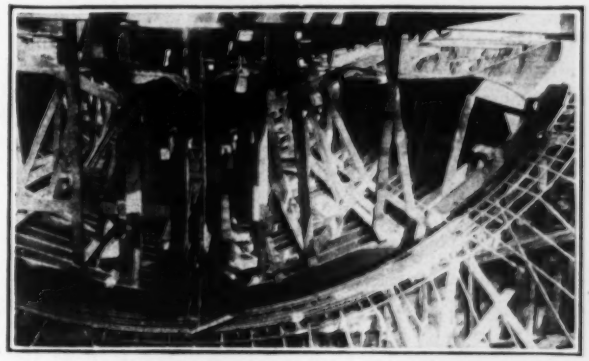
Typical Circular Section

SCHEME OF DISTRIBUTION AND TYPICAL DUCT SECTIONS

ible because of smoke and gases. Longitudinal ventilation, as used in steam and electric train tunnels and in mine tunnels, was rejected for six reasons: (1) In tunnels so ventilated, the pollution of the air gradually increases from the point of entry of the fresh air to the point of exit of the vitiated air. If this maximum allowable degree of pollution is obtained only at the exit, it is evident that there is a great waste of supplied air and power throughout the greater portion of the subway. (2) There will be a noticeable draft due to the high velocity of the large volume of air necessary to ventilate the entire length of subway roadway. (3) There is a great fire hazard of flames spreading along the entire line of vehicles in case of a fire and traffic jam, with the accompanying hazard of having the entire length of subway filled with smoke and interfering with relief work. (4) Large quantities of air could be sent through the roadway section, as a duct, only with excessive power, which would be costly. (5) Two lines of traffic moving in opposite directions are not feasible, owing to the churning effect and air eddies, unless the lanes are separated by a partition. (6) Considerable discomfort would be experienced by passengers in open cars driving against the current or exposed to smoke and gases present.

In the transverse method, as used in the Holland Tunnel in New York, the air, both fresh and vitiated, is to be carried in large ducts separated from the roadway and is to be kept under pressure which will force it continuously across the roadway, transverse to the direction of traffic, the rising, vitiated air being exhausted through the ceiling. Advantages of the method are: (1) All air throughout the subway is of the same degree of pollution, requiring the minimum amount of fresh air, which is about 50 per cent of the quantity of fresh air required for a longitudinal ventilation system that would permit the same degree of pollution. (2) No draft is noticeable to the passengers as the movement of the air is vertical and spread over the entire width of roadway. The high velocity of air occurs only in the large main air ducts, which are separated from the roadway. (3) In case of a fire and a traffic jam, the fire is localized and prevented from spreading due to the air currents being upward and not along the line of traffic. In such a case the exhaust fans may be speeded up to withdraw more quickly the localized smoke. (4) The air may be supplied from several different sources, making the system more flexible and reducing the power cost. (5) It is equally adaptable to traffic in either or both directions. (6) Passengers get the maximum degree of comfort because the vitiated air in rising to the ceiling passes the breathing zone once only.

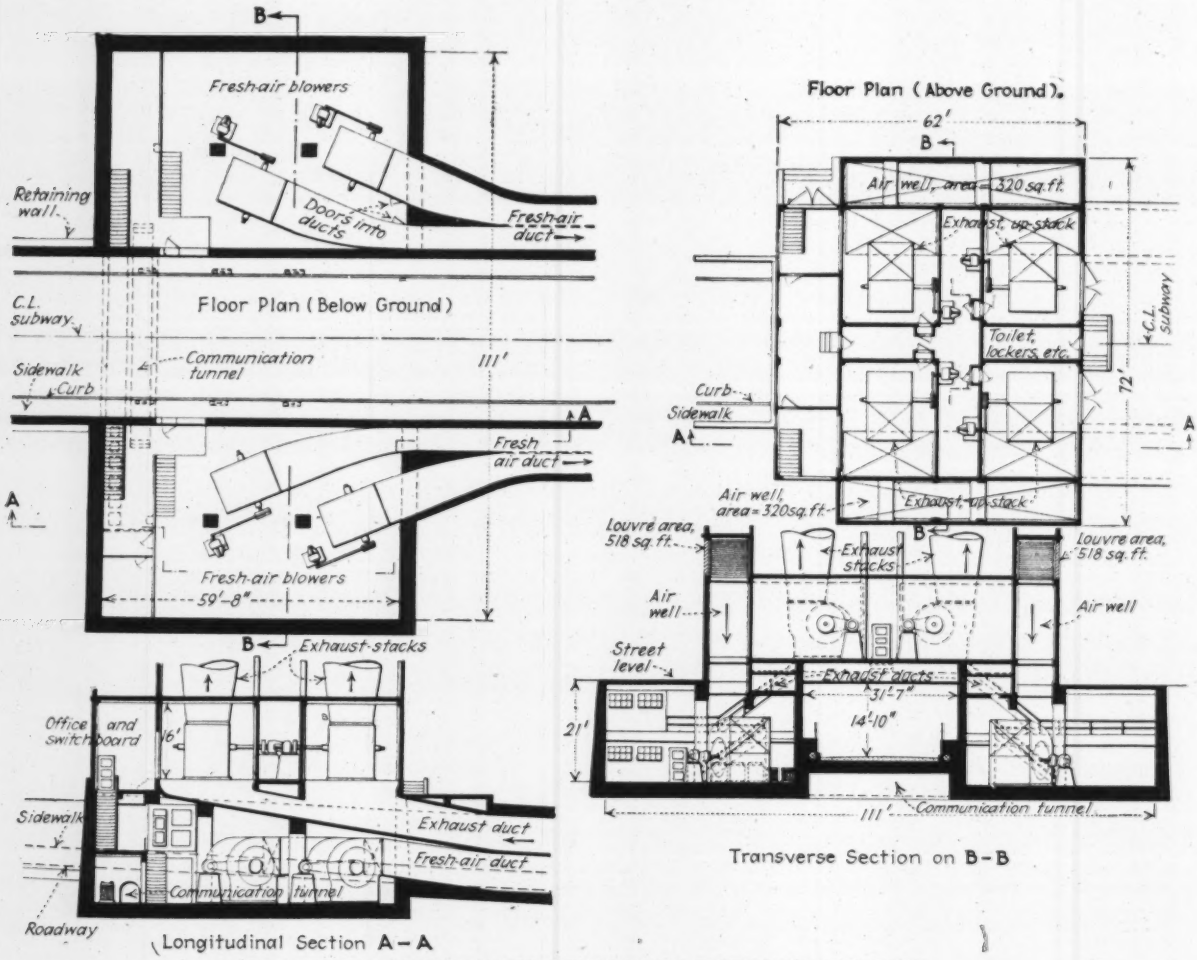
The estuary subway is to be entirely of reinforced concrete and has a total length of 4,435 ft. of which 3,545 ft. is covered and requires ventilation, and 890 ft. is in open approach cuts. Commencing at Sixth and



FORMING FRESH AIR DUCTS UNDER ROADWAY IN CIRCULAR STRUCTURE

Harrison Streets in Oakland, the subway, which is located on the center line of Harrison St., descends southerly on a 4.59 per cent grade to a level at which the roadway is about 68 ft. below mean lower low water in the estuary, continues thence 725 ft. on flat grades across and under the estuary and then ascends on a 4.50 per cent grade, curving to the center line of Webster St. near Tynan Ave., in Alameda.

The covered portion being located, in part, under city streets, the shapes of the various sections are varied to suit the ground and ventilation conditions. The most economical and desirable section of a subway structure, from a structural and ventilation standpoint,



PLAN AND ELEVATION OF VENTILATION EQUIPMENT BUILDING

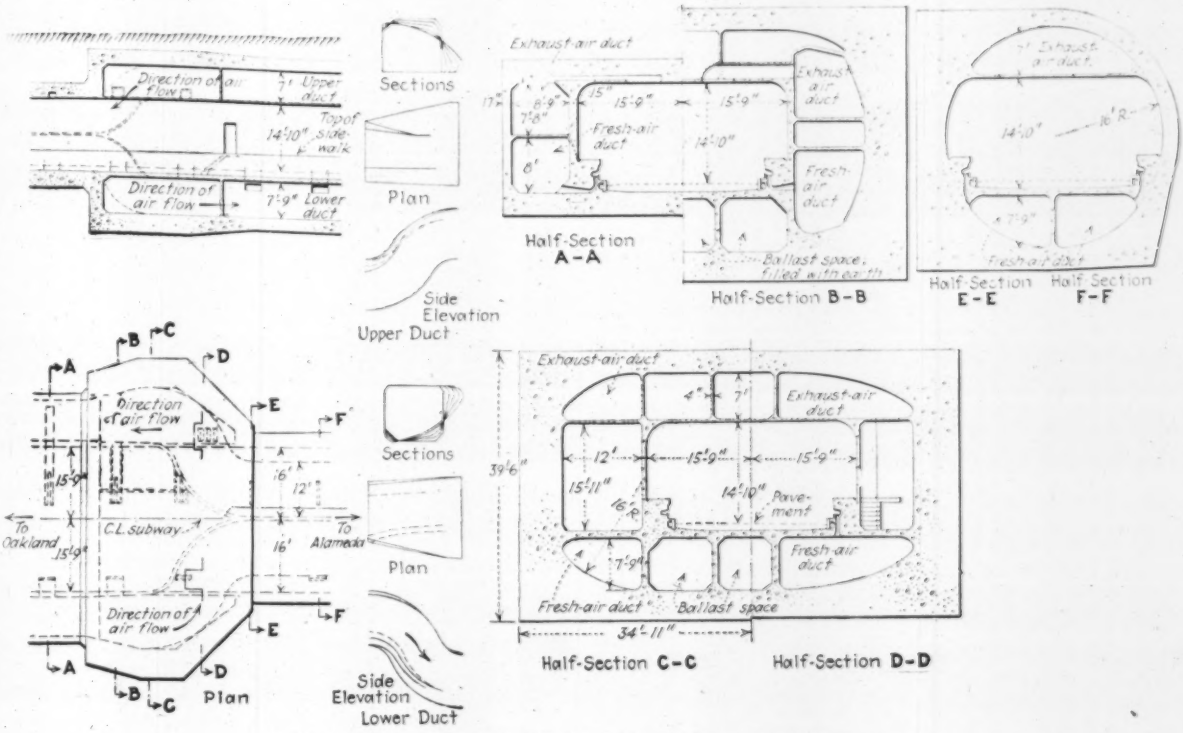
is circular, with the segmental-shaped fresh-air duct below the roadway and the segmental-shaped vitiated-air duct above the roadway ceiling slab. This circular structure was used in the greater part of the estuary tube. On the Oakland side, where the structure is located along and under Harrison St., a circular structure was out of the question, however, due to the lack of sufficient headroom. It thus became necessary to design a rectangular structure for this location until a depth of covering was reached which would make a circular section possible. The rectangular section has two square fresh-air ducts and two similar shaped vitiated-air ducts, one of each type located on either side of the roadway.

The transition from the rectangular to the circular structure was rather complicated both in design and construction. However, a complete transition from the main rectangular air ducts on the sides of the roadway, to segmental-shaped ducts above and below the roadway was accomplished in a length of 37 ft. without loss of cross-sectional area or encroachment on the roadway area, with very little added friction loss and on easy curves. The large air ducts change position through double reverse curves and also change shape from square to half-segmental sections.

In general, the subway is divided into three main longitudinal divisions extending from portal to portal: (1) the roadway for vehicular traffic having a maximum width of 32 ft., including a sidewalk on either side, and a roadway proper of 22 ft. 10 in. wide between curbs; (2) the main fresh-air ducts located below or to the sides of the roadway; and (3) the main vitiated-air ducts located over or at the sides of the roadway. A transverse partition bulkheads the main air ducts about midway between the portals, thus dividing the ventilating system into two separate units, one operated from the Oakland portal building and the other from the Alameda portal building.

SUBSTRUCTURE VENTILATION EQUIPMENT BUILDING, FAN ROOM LEVEL

The fresh air is to be forced through ducts a dis-



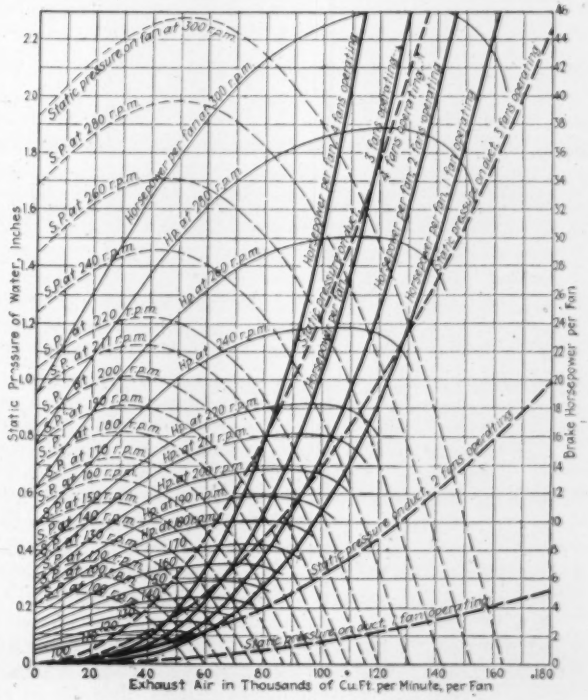
PLAN AND SECTIONS OF VENTILATING DUCT TRANSITION

tance of approximately 1,700 ft. from each portal to the bulkhead midway in the tube. The fresh-air ducts on the Oakland side on leaving the portal building are on opposite sides of the roadway and are square in shape for a distance of 360 ft. until they reach the transition structure. Here the fresh-air ducts change from the sides to a position beneath the roadway, and change shape from the square to the half-segmental section which shape they maintain, separated by a center wall, until the bulkhead is reached. On the Alameda side from the portal building to the bulkhead a large segmental-shaped air duct under the roadway is maintained without change of shape or position.

Being under pressure, the air is to be forced into the continuous expansion chambers through 6x42-in. air flues spaced at 15-ft. intervals longitudinally on both sides of the roadway. The openings of these flues into the expansion chambers are to be adjusted by means of asbestos board slides by amounts to be determined by the static pressure curve of the main duct. The air from these flues is to be forced into continuous expansion chambers of trapezoidal shape, located a few inches above the roadway curbs. The outside faces of these chambers are continuous steel plates, which are adjustable, the openings at the top forming a continuous slot through which the air is to be forced out into the roadway in a continuous sheet under the bodies of the passing vehicles. The width of opening in these slots ranges from ¼ to 2½ in. and will be determined by the static pressure curve of the duct.

The vitiated air is to be withdrawn into the main vitiated-air ducts through pairs of exhaust ports in the ceiling slab spaced at 15-ft. intervals longitudinally. These ports have a maximum opening of 5½x72 in. by means of zinc slides which adjust the opening to any width within the 5½-in. limit. The amount of opening to be provided at the various ports is to be determined from the static pressure curves of the main vitiated-air ducts.

The vitiated-air duct is segmental in shape on the Alameda side from the bulkhead to the portal building. On the Oakland side the vitiated air duct is segmental in shape from the bulkhead to the transition structure,


Static Pressure of Water, Inches
Brake Horsepower per Fan
Exhaust Air in Thousands of Cu.Ft. per Minute, per Fan
Static pressure on fan at 300 r.p.m.
S.P. at 280 r.p.m.
S.P. at 260 r.p.m.
S.P. at 240 r.p.m.
S.P. at 220 r.p.m.
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S.P. at 120 r.p.m.
S.P. at 100 r.p.m.
Hp. at 280 r.p.m.
Hp. at 260 r.p.m.
Hp. at 240 r.p.m.
Hp. at 220 r.p.m.
Hp. at 200 r.p.m.
Hp. at 180 r.p.m.
Horsepower per fan at 300 r.p.m.
Horsepower per fan, 1 fan operating
Horsepower per fan, 2 fans operating
Horsepower per fan, 3 fans operating
Static pressure index, 2 fans operating
Static pressure index, 3 fans operating
Static pressure on duct, 1 fan operating

TYPICAL CHART OF CHARACTERISTIC VENTILATION CURVES

where it is divided into two half-segmental shaped ducts gradually changing to a square shape and changing position from over the roadway to the sides of the roadway from that point to the portal building.

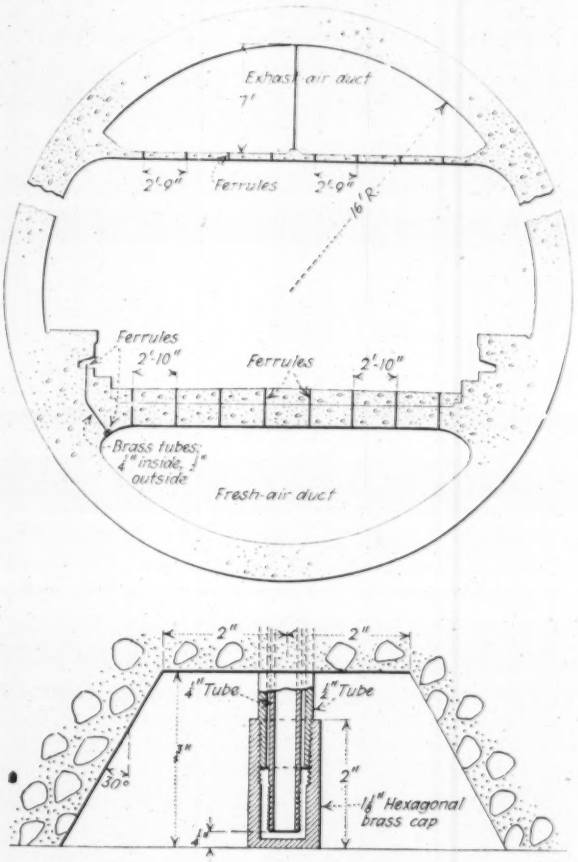
It was originally intended to place the ventilation equipment buildings at the quarter points of the covered portion, and to ventilate the subway for a quarter of the length in each direction from each building. Prior to the detailed studies this appeared to give the best air distribution system, although it meant very large and deep sub-surface equipment structures. However, ventilation studies showed conclusively that if these structures were designed of a size that it would be practicable to construct, the air losses, due to small air ducts and complicated elbows at the source of air supply, would increase the power requirements to a prohibitive amount. Further studies by the author showed that by placing the equipment buildings at the portals and ventilating half of the subway from each building, not only would their cost, size, depth and construction difficulties be enormously decreased, but the ventilation system would be more direct and positive and the power requirements would be greatly reduced. Also, the source of fresh air being thus removed from the proximity of passing trains on First St. the air would not be polluted by smoke and would not need to be washed. In addition, the equipment buildings being built at and around the portals would afford, with proper architectural treatment, monumental entrances to the subway in each city.

The ventilation equipment buildings as finally designed consist of subsurface structures divided into two large chambers on either side of the roadway to house the large fresh-air fans, which will draw their supply of air into the chamber from the atmosphere through large air wells extending into the superstructure and having louvers through their walls. The fresh air will not be washed, owing to the absence of factories or steam trains in the vicinity of the portal buildings. Transformers, switchboards, motors and other equipment will also be housed in these buildings. The large exhaust fans are to be housed in the superstructure, each fan being located in a separate gas-tight room, having large floor openings, with damper doors, connecting with the large vitiated-air chamber below the main floor.

TABLE I—DISTRIBUTION OF VEHICLES IN SUBWAY

Type of Vehicle	Per Cent of Total
5-passenger cars	30
7-passenger cars	20
Trucks, 1½ tons or less	15
Trucks, 1½ tons to 3 tons	15
Trucks, 3½ tons to 4½ tons	10
Trucks, 5 tons or over	10

Upon reaching the portal buildings the vitiated air is expanded, with the loss of all velocity pressure, into large vitiated-air chambers located under the exhaust fan room floors. The vitiated air is to be exhausted from the building through curved evasé stacks into the atmosphere at a point sufficiently removed from the fresh air louvers to prevent the short-circuiting of the vitiated air with the fresh air. The exhaust fan rooms, fresh air wells, exhaust stacks and operators' control room are all combined in a structure directly above and overlooking the approach. The operator from his outlook and with the communicating signal and telephone system will have complete control of traffic at all times and in addition to his normal duties of supplying



TYPICAL AIR TRAVERSING STATION AND ONE OF SEVERAL TYPES OF FERRULES

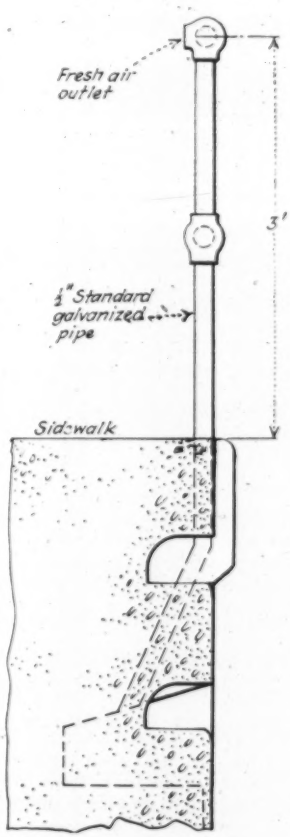
ventilation to meet the needs of the traffic, can furnish emergency ventilation in case of a fire and traffic jam and perform such other duties as may be necessary to safeguard the traffic.

At frequent intervals throughout the subway, particularly at points where the shapes of the air ducts change, air measurement stations are located. These are constructed by placing a series of ferrules at close intervals in the walls of air ducts through which instruments are inserted and the area of the ducts traversed and the center constants determined. After the characteristics of the ducts are determined further readings are taken by pitot and piezometer tubes in stations located at various points through the subway where velocity pressure, static pressure and total pressure may be determined as desired. When the fans are installed extensive readings will be taken to determine the final adjustments to be made on the width of openings of the various fresh air flues, continuous slot and exhaust ports and also as a check on the formulas used.

It is proposed to install the automatic carbon monoxide recorder and alarm, which has been recently developed by the U. S. Bureau of Mines. By means of this instrument a continuous record graph is kept of the concentration of carbon monoxide in the subway air. The instrument may be electrically connected to an alarm or to the switchboard and more power may automatically be furnished to the fans, should the concentration of carbon monoxide exceed that allowed. The principle upon which this instrument operates is the registering by means of thermocouples and a poten-

tiometer of the heat generated by the chemical union of carbon monoxide and oxygen.

As a result of extensive experiments carried on by the New York and New Jersey State Bridge and Tunnel Commission and the U. S. Bureau of Mines in their experimental tunnel at Bruceton, Pa., and later from tests on actual traffic in the Liberty Tunnel at Pittsburgh, Pa., the amount of carbon monoxide, which is the poisonous constitutent of motor exhaust gases, has been accurately determined. These tests cover various types of cars, loadings, weather conditions, speeds and roadway grades. It has further been found, as the result of extensive tests on volunteer subjects made for the tunnel commission by Dr. Yardell Henderson, of Yale University, that when human beings are subjected to motor exhaust gases diluted to a concentration of 4 parts of carbon monoxide to 10,000 parts of fresh air for a period not exceeding one hour, no noticeably harmful effect is apparent. This concentration of 4:10,000 is approved by the U. S. Bureau of Mines as permissible for public safety, and is the standard adopted as the maximum degree of pollution in working out ventilation problems on the estuary subway.



DETAIL OF HANDRAIL VENTILATION SCHEME

A feature of the design is the connection between the sidewalk pipe rail and the expansion chamber at frequent intervals whereby a small supply of fresh air is provided for the use of traffic police, who may be stationed in the subway for long periods of time and for passengers who may be temporarily overcome in accidents.

From a study of past and present vehicular traffic counts to and from Alameda, over the Webster St. bridge, which is to be replaced by the estuary subway, the amount, distribution and variation of traffic were determined and an operating schedule adopted. Table I shows the probable distribution of types of vehicles that are being provided for.

Traffic through the subway is to be under the control of traffic police at all times, and, accordingly, computations were based on traffic in two lines moving in opposite directions at 10 miles per hour and spaced 40 ft. apart in each line. On this basis Table II indicates the amount of carbon monoxide to be exhausted and the fresh air required to properly dilute it, for the level and the average of up and down 4½ per cent grades.

The fact that the computations have been made on the above basis should not be misconstrued to mean that such speed and car spacing must be adhered to. This set of assumptions was used and carried through consistently to give known points on the characteristic curves from which, knowing the equations of the curves, it is a simple matter to compute any quantity or for any demand up to capacity of the equipment.

TABLE II—QUANTITIES OF CARBON MONOXIDE AND FRESH AIR

		Cu.Ft. of CO per Hr. per Ft. of Subway		Cu.Ft. of Fresh Air per Min per Ft.	
	Per Cent	Level	4.5% Grade	Level	4.5% Grade
5-passenger cars	30	0.660	0.713	27.50	29.71
7-passenger cars	20	0.760	0.893	31.67	37.21
Trucks, 1½ tons or less	15	0.443	0.480	18.46	20.00
Trucks, 1½ tons to 3 tons	15	0.780	0.790	32.50	32.92
Trucks, 3½ tons to 4½ tons	10	0.740	0.615	30.83	25.63
Trucks, 5 tons and over	10	0.760	0.723	31.67	30.13
Totals	100	4.143	4.214	172.63	175.60

TABLE III—VENTILATION VARIATION FOR FULL CAPACITY AND LESS-THAN-CAPACITY

	Full Capacity Traffic				Less-Than-Capacity Traffic			
Speed of Traffic M.P.H.	No. Cars Passing per Hr.	Spacing in Each Line Ft.	Cu.Ft. CO per Hr.	Fresh Air Cu.Ft. Min.	No. Cars per Hr.	Spacing in Each Line Ft.	Cu.Ft. CO per Hr.	Air C.F.M.
6	1,584	40	10,280	428,500	1,583	40	10,275	428,100
10	2,640	40	15,390	641,280	1,583	66.7	9,230	384,590
15	3,960	40	17,980	761,020	1,583	100	7,190	299,590
20	5,280	40	22,620	942,720	1,583	132.4	6,780	282,503
25	6,600	40	26,030	1,084,570	1,583	166.6	6,250	260,410
30	7,920	40	28,550	1,189,480	1,583	200	5,710	237,920

Each equipment building has been designed to accommodate four large fresh air fans and four large exhaust fans. As the air quantities are large and the static pressures relatively low, the fans selected have backward-curved blades which will operate in parallel on the same duct at different speeds. At the present time sufficient air supply will be furnished by half the total number of fans, to be driven by four-speed alternating-current 3-phase squirrel-cage induction motors of 5 to 75 hp. As traffic increases and more air is required, more fans will be added. This ultimate installation will furnish over 1,000,000 cu.ft. of air per minute and exhaust the same amount, together with the increment added due to the higher temperature of the vitiated air. These figures are based on ventilation for full capacity traffic in both lines at a speed of between 25 and 30 miles per hour. Upon the opening of the subway the speed of traffic will be regulated according to needs. It is not believed, however, that the full demand on the ventilating equipment will be reached within twenty years, by which time other arteries of travel will doubtless be provided.

The most important objection to be raised against mechanically ventilated subways is the hazard of possible interruption of power to drive the fans. To minimize this hazard the estuary subway is to be directly connected to four independent sources of power, two hydro-electric and two steam plants, which are interconnected by automatic switches. A calamity of such major proportions as would interrupt all four sources of power, would naturally be sufficiently serious to justify drastic traffic control.

Assuming a minimum spacing of cars in the line of traffic the following interesting fact regarding economy of ventilation is apparent: For traffic of such density that the subway will be continuously filled, the most economical ventilation operation will obtain with the lowest speed allowed. Also, for any traffic density less than that which will continuously fill the subway, greater economy will result by speeding up the traffic, which permits the few cars to remain in the subway a minimum length of time. Table III shows this variation for two cases taking cars with minimum spacings of 40 ft. in each line.

When transverse ventilation was adopted for so long a tube as the Holland tunnel it was found that the ordinary ventilation formulas, as commonly used in building and tunnel ventilation, would not answer. Requirements of the Holland tunnel were that the air should be uniformly supplied and exhausted at close intervals throughout the length of a system using large ducts and great quantities of air at relatively low pressure. In order to develop satisfactory working formulas the New York and New Jersey Bridge and Tunnel Commission worked in conjunction with the U. S. Bureau of Mines and the engineering experiment station of the University of Illinois. With the data on exhaust gases of motor vehicles and their effect on human beings as a basis, on model ducts of large sizes extensive tests were made of the frictional losses which would have to be overcome in moving large volumes of air through large concrete and metal ducts and elbows and delivered at frequent intervals through flues of various sizes and shapes. The formulas developed, which are extremely complicated, are a distinct addition to engineering knowledge. Due acknowledgment is hereby given to the commission and to other engineers connected with the tests used in developing the formulas, which were used in the ventilation design of the estuary subway.

All work on the estuary subway has been under the supervision of George A. Posey, chief engineer, and Austin W. Earl, engineer of designs. The board of consulting engineers consisted of the late Clifford M. Holland, Prof. William H. Burr of New York City and Prof. Charles Derleth, Jr. Since the death of Mr. Holland, Ole Singstad has been appointed to succeed him on the board. The author wishes to make acknowledgment here of assistance received from A. C. Davis, mechanical and ventilation engineer of the Holland Tunnel.

Concrete Road Curing Tests Reach Useful Stage

By J. T. Pauls
Highway Engineer, Bureau of Public Roads, Washington, D. C.

Extract from progress report on tests by the Bureau of Public Roads as published in "Public Roads," December, 1926.

TO OBTAIN information about the effect of moisture and temperature changes in concrete slabs immediately after laying and to determine the effect of various curing methods and of subgrade friction there were built in August, 1926, at Arlington, Va., 40 concrete slabs each 200 ft. long, 2 ft. wide and 6 in. thick. The concrete was 1:2:4, of Potomac River sand and gravel. The mixing and placing were done under weather conditions as nearly identical as possible. Construction and curing covered a wide range of variables. In some of the slabs cross-joints were installed at varying distances 20 to 60 ft. apart and other slabs had none; some slabs were reinforced in varying ways and degrees and others were plain concrete; dry and wet subgrades were employed, and about all of the modern methods of curing were employed on one slab or another.

Various problems are being studied and on a few of these sufficient indications have been obtained to warrant presentation:

(1) The greatest loss in moisture occurred during the first 24 hours after pouring. The loss in slabs laid on dry subgrade without curing is about 4½ times that in slabs laid on wet subgrade and cured 24 hr. with wet burlap.

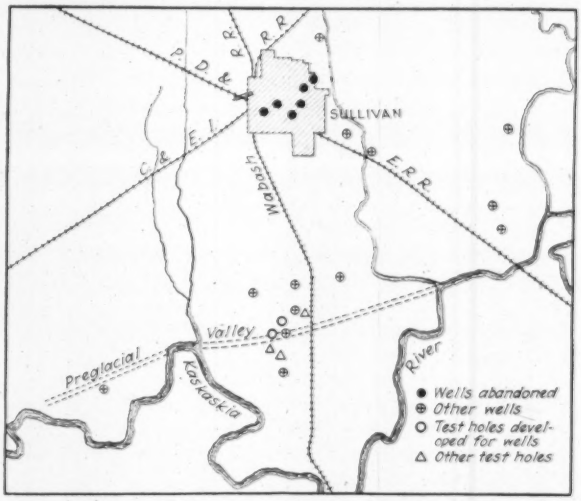
(2) Certain types and amounts of reinforcement continuously placed greatly reduce the shrinkage coefficient of concrete pavement.

(3) Subgrade resistance to slab movement is larger on medium wet than on dry subgrade.

(4) Curling is greatest at the slab end and the maximum bending moment is 6 to 8 ft. from the end.

Buried River in Illinois Furnishes Ground-Water Supply

A NEW municipal water supply for Sullivan, Ill., is derived from two 115-ft. wells in a buried gravel-filled preglacial valley of the Kaskaskia River, as described in a paper read at the recent meeting of the Illinois Society of Engineers by W. D. P. Warren, consulting engineer, Decatur, Ill. The situation is shown by the accompanying drawing. For the old supply there were six wells of 8 to 12-in. diameter and 90 to 300 ft. deep, but as these were more or less unsatisfactory it was first thought that the final solution of the water problem would be an impounding reservoir and a filtration plant.



WELLS AND TEST HOLES AT SULLIVAN, ILL.

The city, however, authorized a study of the possibilities of a ground-water supply, the result of which is thus described by Mr. Warren:

The Kaskaskia River above the site of the new wells, has a drainage area of about 700 sq.mi., and as the preglacial valley of the river here is about 100 ft. deeper than the present valley, the underground drainage of practically the entire area is available as a source of supply.

By the use of an automobile it was possible to visit numerous old farm wells in a short time and to confer with farmers and local well drillers as to formations encountered. It developed that a number of isolated farm wells had penetrated the buried valley of the Kaskaskia, but no significance had been attached to them owing to a lack of knowledge of the occurrence and movements of ground waters. All the wells penetrated water-bearing sand and coarse gravel. A close inspection was made of all formations encountered and the test holes were located rather to fix the boundaries of the buried river valley than to develop city wells. This important distinction is often overlooked in studies for water supply development.

Each of the new wells was reamed out to 30-in. diameter for the full depth of 115 ft. A 24-in. outer casing and 18-in. inner casing were then installed, and the spaces between the casings and beyond the outer casing were filled with selected gravel to form a porous wall around the well strainer for the full depth of the water-bearing formation, about 45 ft. This construction was adopted to develop a free flow of ground water into the well and to develop the supply with a minimum draw-down, or in other words, with a minimum pumping cost. Each well has a deep-well centrifugal pump of the turbine type, with a capacity of 650 g.p.m. and driven by a 75-hp. motor. These pumps, installed in separate brick buildings, operate against a total head of 250 feet.

All water is pumped through venturi meters (one for each well) to a 10-in. main leading to a 100,000-gal. elevated

steel tank, about 14,000 ft. from the wells. With 12 miles of 6- to 10-in. mains, hydrants, valves and other appurtenances, including 11,000 ft. of power transmission line, the total cost for new supply and distribution improvements was about $210,000. Land, right-of-way and water rights cost only $1,500, while an impounding reservoir would have required several thousand acres; with the dam, filtration plant and other necessary features it is estimated that an equal supply of surface water would have cost more than $1,000,000.

At Sullivan, the normal daily requirement for a population of 2,500 is 250,000 gal., but to provide for future growth and for ample fire protection the wells were so constructed as to have a combined capacity of about 2,000,000 gal. daily, this condition warranting the slight additional cost for the large diameter of gravel-cased wells.

Proportioning Pit-Run Aggregate in Concrete

A Simple Formula for the Determination of Proportions Based on the Crum Method of Weighing Aggregate

By J. H. Griffith

Professor of Experimental Engineering, Iowa State College, Ames, Iowa

In a paper by R. W. Crum in 1919 before the American Society for Testing Materials (*Proceedings* A.S.T.M., Vol. XIX, p. 459) there was given a method of proportioning pit-run aggregates for concrete which has come to be widely and favorably known among engineers by reason of the extreme simplicity of its field technique. In the application of the method the specific weight of the material is determined with a spring balance and a suitable retainer, the sand content found as a percentage with a ¼-in. sieve, the proper mix being taken as a function of these variables by the use of appropriate charts as discussed later.

The method is firmly grounded scientifically in that it is based upon the researches of Feret who established the fact that the strengths of mortars and concretes are directly proportional to the cement contents and inversely proportional to the amount of voids regardless of "the nature and size of the sand, the proportions of the elements—sand, cement and water—of which each is composed" (Johnson's "Materials," 5th ed., pp. 455 and 464). The method is related on the one hand to the more comprehensive scheme of D. A. Abrams in that the sand percentage as determined with a single sieve is analogous to the function known as the "fineness modulus" which is obtained with nine sieves by a suitable averaging of the percentages coarser than a given size as found by mechanical analysis; and it is related to the "surface area" or adsorption method of proportioning devised by L. N. Edwards in the fact that both Crum and Edwards condition the amounts of cement by the amounts of finer material in the aggregates. The method of Crum gives test results that are intermediate between those obtained by the two other authorities.

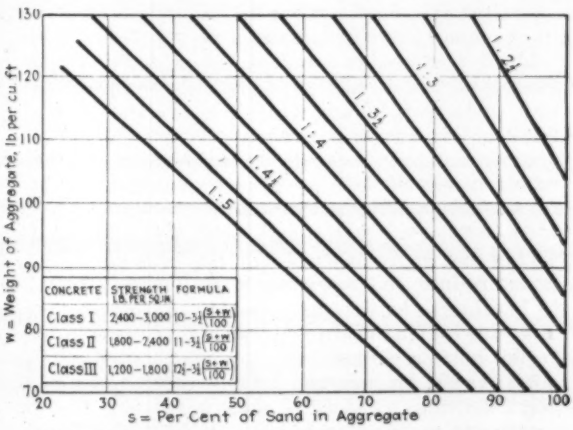


DIAGRAM FOR PROPORTIONING PIT-RUN GRAVEL DEVISED BY R. W. CRUM

This diagram is for Class I concrete and the formulas are those devised by Prof. Griffith to fit similar diagrams for classes I, II and III concrete.

It is the purpose in this paper to show how the data of Crum's charts may be incorporated into an extremely simple formula easily retained mentally and supplementing the charts for field use without a sacrifice of accuracy. There are three of these charts, the one shown in the figure defining the mixes for Class I concrete with a strength ranging from 2,400 to 3,000 lb. per sq.in., Classes II and III having corresponding strengths of 1,800 to 2,400 and 1,200 to 1,800 lb. per sq.in. respectively. It will be noticed that the lines in the chart which give the mixes—those on the others being similar in character—are functions of the unit weights of the aggregates and the sand percentages as given by the ordinates and abscissas of the diagram (loose volumes being considered in this connection); or expressed analytically $m = f(s, w, p)$ where s gives the percentage of the sand, w is the weight of the gravel per cubic foot, and p represents a parameter or "variable-constant" depending upon the relative strengths of the three classes of concrete.

The function for the required mix ratio $m/1$ appears as a sort of warped surface with the extreme upper and lower horizontal lines of the diagram defining the mix serving as the projections of the directrices of this surface. It is accordingly natural to disregard the higher order terms for the general surface $m = f(s, w, p)$ from calculus in the first approximation to the data of the charts and try a contact or secant plane to see if it will represent the data sufficiently close for practical purposes within the limits prescribed by the boundaries of the charts.

To this end several tentative formulas were obtained by the practice of setting particular mixes from the diagrams in equations for the plane and solving for the coefficients as in the theory of empirical equations. The tentative expressions suggested the trial form $m = p + c\left(\frac{s+w}{100}\right)$ as a possible equation for representation of the data of the charts. It was found almost immediately that the formula $m = p - 3\frac{1}{2}\left(\frac{s+w}{100}\right)$ would meet all the conditions very closely using $p = 10$ for Class I, 11 for Class II, and $12\frac{1}{2}$ for Class III concretes respectively. Mr. Crum states in his paper that "it will not be practical to state the proportions any closer than the nearest half or quarter part of aggregate." The formula is usually well within this tolerance even in the extreme cases. If it is desired to get the proportions by weights the values for m may be multiplied by a constant which may be taken $w/94$ or $1\frac{1}{4}$ in the case of the published data. The constant and coefficients may be expected to vary slightly depend-

ing upon the mineralogical properties of the materials. It is evident, however, that it will be an easy matter to adjust the coefficients to suit different districts, without difficulty still retaining their simple values.

An example will make the use of the formula clear. Suppose a pit-run gravel weighs 110 lb. per cu.ft. and the sand content as found with a ¼-in. sieve is 60 per cent by weight. The required mix m of the aggregate for one part of cement—both measured by loose volumes as prescribed by Crum—is

$$10 - 3\tfrac{1}{2}\left(\frac{170}{100}\right) = 4.05 \text{ for Class I,}$$

$$11 - 3\tfrac{1}{2}(1.7) = 5.05 \text{ for Class II and}$$

$$12\tfrac{1}{2} - 3\tfrac{1}{2}\ (1.7) = 6.55 \text{ for Class III concretes,}$$

the corresponding figures interpolated from the charts being 3.97, 4.97 and 6.50. The formula holds for aggregates containing as low as 20 per cent sand as well as those consisting of pure sand with a range of unit weights from 70 to 130 lb.

The writer has been informed by Walter Dunagan, highway engineer, that the chief utility of the formula will be found in making hurried mental calculations of mixes from estimates of the weights and sand contents in inspections at the gravel pits. From the author's point of view it is important in reducing the results of tests to a concise analytical expression which may be later readily extended to include other variables than those mentioned.

Rio Grande Development Project in New Mexico

Conservancy District Plans Irrigation, Drainage and Flood Protection on 150 Miles of River—Field Work in Progress

By R. G. Hosea
Civil Engineer, Albuquerque, N. M.

ONE of the largest development projects of the Southwest is that of systematic irrigation, land drainage and flood protection in the middle valley of the Rio Grande River, in New Mexico, from White Rocks canyon south to the head of the Elephant Butte reservoir at San Marcial, N. M., a distance of about 150 miles. Drainage is perhaps the most urgent need, but the other two objectives are only less urgent. The Middle Rio Grande Conservancy District has been organized to carry out the work.

Below the Rio Chama the river is heavily laden with silt, and each tributary adds to its burden, especially the Rio Puerco (dirty river) and the Rio Salado (salty river), which enter from the west near the lower end of the reach, and both of which are subject to violent floods. Due to some combination of causes, it appears that Nature's nice balance of forces was disturbed here in comparatively recent times and the Rio Grande began to deposit its silt, building up its bed and raising itself above the adjacent country, which then became subject to overflow by every abnormal freshet. The low lands became swamps, where water fed by seepage and overflow from the river stood at the surface of the ground. Also, irrigation water is used lavishly, which is not surprising in a country where irrigation has been practiced without legal restraint for over 200 years. Besides, the ditches have been elevated above the country in much the same way as has the river, by the annual deposition of silt, so that the beds of many of the *acequias* (canals) in the valley are six to eight feet above the lands they serve; seepage from them has helped to raise the groundwater level of the country.

Due to these conditions the groundwater level of a large part of the middle Rio Grande valley has been raised to a point very near the surface, while over large areas it is actually at the surface. Other tracts show the effect of the rising water table and indicate that before long their value as farm lands will be greatly reduced, if not entirely destroyed. As a whole the acreage irrigated in the valley has greatly decreased and the character of the crops grown has changed as the groundwater rose. Many farms have been abandoned entirely.

The need of drainage on a large scale has been evident for some years. It has been recognized also that the middle valley needs two other improvements: (1) A complete irrigation system to consolidate and perhaps improve the seventy-odd ditches now in use, and (2) a storage reservoir to equalize the flow of the river, 60 per cent of which now occurs during the annual spring flood.

Floods periodically do great damage to cities, towns, railroads and farm lands over a stretch of river 170 miles long. Albuquerque, with 32,000 inhabitants, is menaced annually. San Marcial, a small railroad town, exists precariously by virtue of eternal vigilance and inadequate dikes or levees, which it is hoped will hold the river in its channel several feet above the level of the streets. Other communities are menaced in less degree, but nevertheless seriously. Some form of river control is imperative for safety, and the project includes such control as a vital feature.

Most reclamation projects contemplate the irrigation of virgin land and the development of a new territory. But here the land to be reclaimed is probably the oldest irrigated area in the United States, as it was already under irrigation by the Indians when the valley of the Rio Grande was discovered by the Spaniards under Coronado in 1540. It is not necessary to create new values, new transportation systems and new markets. There are 35,000 landowners in the valley at present, with holdings worth fifty or sixty million dollars. The value of these holdings is decreasing; but with drainage, irrigation and flood control established, present values will be many times increased.

Much preliminary work finally crystallized into the passing of a law similar to the conservancy laws of Ohio and Colorado, and under this law the district was formed. Its officers proceeded to create an engineering organization to investigate the problem, and (if feasible within a reasonable cost) to recommend an official plan for the reclamation of the valley.

One of the big preliminary problems is the land surveying and appraisal, whereby the ownership of lands is determined and assessments are made in proportion to benefits to be derived. In this part of the country there are Indian grants, Spanish grants, Mexican grants, "small holding claims," city lots, sections, feet, chains, miles, varas, leagues and various other measurements and definitions. Old titles sometimes read, "As far as a man can walk (or ride) in a day," "The length of a cigarette," or "To a point on a hill from which the city of Santa Fe can be seen from a horse."

Ditches parallel each other, cross and recross, run

hither and yon, each intent on arriving at its own particular little patch of land. When the river falls in the summer, an industrious mayor domo or canal superintendent may get his gang out and build a sand dam to turn water into his ditch. The big boss on the next ditch downstream, perhaps only a few hundred feet away, may not feel so industrious and may let his dam construction wait. If the crops begin to burn, the Mexican farmers look at the crops, roll cigarettes and shrug their shoulders.

The directors of the Middle Rio Grande Conservancy District appointed J. L. Burkholder as chief engineer and the Dayton Morgan Engineering Co., Dayton, Ohio, as consulting engineers, as noted in *Engineering News-Record* of Dec. 2, 1926, p. 904. C. H. Howell was appointed designing engineer. Edmund Ross, of the Ross Engineering Co., Albuquerque, N. M., is in charge of land surveys. The writer has been engaged in the water supply and storage investigations and irrigation system layouts. Five survey parties have been in the field for months on property surveys and appraisals, and one party on reservoir investigations. Under a co-operative agreement with the U. S. Bureau of Reclamation, certain investigations of stream flow, evaporation, seepage, depth to groundwater, etc., are being made by the Bureau under the supervision of Ivan E. Houk, of Denver, Colo., with C. C. Elder as engineer on the ground. It is thought that the official plan will be completed in the fall of 1927, and should it be approved and the bonds sold, the middle Rio Grande valley will be a scene of much activity for several years.

The present boundary of the district was assumed somewhat arbitrarily, for preliminary legal and other purposes, and includes lands that would not be benefited by the proposed work. The intention is to cut it down to such limits as the official plan may indicate. Included within the area to be benefited by the proposed reclamation work are several thousand acres of Indian lands; in fact about 17 per cent of the total acreage belongs to the pueblos.

The recent Congress passed a bill providing for an appropriation of $50,000 to cover the cost of the preliminary work for the official plan on Indian lands lying within the boundaries of the district. It also provides that the Commissioner of Indian Affairs shall designate an engineer to represent the Department of the Interior in the preparation of plans and report.

Lime and Plaster-of-Paris Studied by X-Ray

X-ray examination has been applied by the Bureau of Mines and the Massachusetts Institute of Technology to the study of certain problems in lime and in plaster-of-paris. In the case of lime, the method was used to determine whether there is any structural relationship between lime and the stone from which it is made. In the case of plaster-of-paris the purpose was to investigate the deterioration resulting from recalcination, the strength virtually reaching zero at the fifth calcination, while the water-carrying capacity of the material is more than doubled. From the investigation it was concluded that the change is probably due to changes in size of particles, possibly brought about by particles of uncalcined plaster acting as centers of crystallization. By the addition of small percentages of promoters, the strength can be greatly increased, according to the report of the director of the bureau, just issued.

Revised Rivet Pitch Formula Advocated as Time-Saver

By A. Frank
Consulting Engineer, Newark, N. J.

Computing rivet pitches in plate girders by the so-called moment-of-inertia method, which is the one the writer favors, is usually considered somewhat more difficult than by the chord-stress method. But if the static moment in the moment-of-inertia equation could be replaced by available tabular quantities then the moment-of-inertia method would be received much more favorably. The following derivation was made with this end in view.

When the rivet pitch in a plate girder is computed by the chord-stress method, the formula

$$p = \frac{rh}{KV} \qquad (1)$$

is used, in which r is the allowable total stress on each rivet; V the total shear, and h the depth of the girder. K is unity when the web is not considered to take any bending, but is usually taken as $A_f / \left(A_f + \frac{W}{8}\right)$ which is the area of one flange divided by the sum of the area of one flange plus one-eighth the area of the web.

When the rivet pitch is figured by the moment-of-inertia method, we use the horizontal-shear formula.

$$p = \frac{rI}{VQ} \qquad (2)$$

in which I equals the moment of inertia of the girder and Q is the static moment of one flange about the neutral axis.

The writer believes that some of the preference for the chord-stress method is due to the fact that in using it the pitch of the flange rivets can be found from the same quantities that are used in finding the resisting moment. On the other hand, with the moment-of-inertia method we must first find the static moment Q, which is a lengthy operation, involving almost the same steps as finding the resisting moment by the chord-stress method. However, if we let I_f = the moment of inertia of both flanges without the web and h the distance from the center of gravity of one flange to the center gravity of the other flange, then very closely

$$I_f = 2 A_f \left(\frac{h}{2}\right)^2; \text{ or, } A_f = \frac{2 I_f}{h^2}$$

Also,

$$Q = A_f \left(\frac{h}{2}\right) = \frac{I_f}{h}$$

Substituting this value of Q in Eq. (2),

$$p = \frac{rI}{\left(\frac{I_f}{h}\right) V} = \frac{rh}{\left(\frac{I_f}{I}\right) V} \qquad (3)$$

It will be noted that Eq. (3) is also Eq. (1) of the chord-stress method with a new value of K, namely I_f/I.

Now whether I is taken from the tables or computed, the I of the separate parts—the cover plates, angles and the web—will be known separately, so that I_f is known when I is known. The value of h may be variously considered according to the accepted authorities, but the writer feels that the depth of the web plate is satisfactory. Also, in applying Eq. (3) the properties of the gross section uncorrected for holes out or for the shift of the neutral axis may be used.

Second of Two Articles on Requirements and Use of Industrial Railway Lines

Industrial Railways for Factory and Construction Work-II

Examples of Practice at Mills and Industrial Plants of Different Kinds—Opinions of Engineers and Contractors on Construction Works—Standard, Narrow and Mixed Gages

By E. E. R. Tratman
Western Editor, *Engineering News-Record*

WHILE diversity of gage might be expected for the industrial tracks in plants of different kinds, owing to differences in requirements and operating conditions, as described in the first article (*Engineering News-Record*, March 3, p. 356), inquiry shows also great diversity in plants of the same kind.

Steel and Bridge Plants

Steel Mills—Of eleven steel works, seven report having narrow-gage tracks with gages ranging from 28 to

NARROW-GAGE TRAIN AT A STEEL FOUNDRY
Note the mixed-gage three-rail track.

42 in., in addition to the standard-gage railway connections. Four have standard-gage exclusively, for all purposes, and consider this satisfactory, although one has a small amount of isolated 36- and 42-in. track for handling material in the mills. Furthermore, the chief engineers of two of the plants having narrow-gage systems consider that in the design of entirely new steel works it would be advisable to use standard-gage only

Many narrow-gage lines are inherited with old plants, and the reasons for the selection of the particular gages are not known. These lines have certain advantages for such special kinds of work as handling cars for charging boxes and ingot molds. The following statements illustrate the conditions in regard to standard- and narrow-gage tracks at steel works. It will be noted that the engineer of one plant expresses a preference for 32-in. where narrow-gage is to be used, but this is one of the odd or little-used widths of gage.

(A) At the new plant, the use of standard-gage exclusively was made possible by location of the departments, buildings and other facilities in such a way as to permit the laying out of curves of sufficient radius for easy movement. Older plants have systems of 36-in. tracks. But these were installed after the works were built, in order to facilitate operations, and narrow-gage was necessary for making the sharp turns and traversing narrow spaces.

(B) Tracks of 36-in. gage are used for the charging cars entering the open-hearth mill and for the ingot cars running thence to the rolling mill. This gage has the following advantages over standard-gage: (1) Special small cars are used which are large enough for the service and are not adaptable to other uses; (2) a wider gage would be more expensive and take up more room without compensating advantages; (3) the short-radius curves which are required on lines of this kind are obtained more readily with narrow-gage tracks.

(C) When this plant was built molten iron was hauled from the blast furnace to the bessemer mill in ladle cars, and a gage of 36 in. was adopted for this service. Later these tracks were extended and used for flat cars carrying ingot molds and charging boxes. This gage was suitable, as the works are in a restricted area and are cramped for room. It is considered, also, that the smaller cars are more convenient for handling the charging boxes, while in handling the molds the greater space and weight of standard-gage cars would be of no service unless two rows of molds could be placed on the cars.

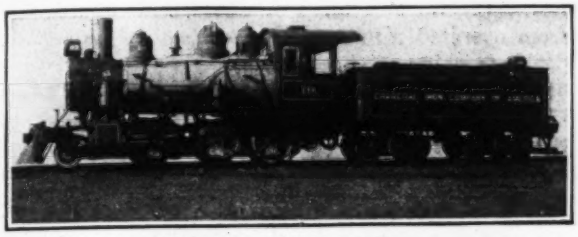
(D) Limited area at the open-hearth plant made it necessary to use narrow-gage tracks, requiring less room for curves and turnouts, and the 42-in. gage was the widest that could be applied with advantage. A standard-gage track connects this plant with the steel mill, about 2½ miles, and a third-rail provides for operating the narrow-gage cars, but this has not proved entirely satisfactory. The 42-in. tracks carry charging cars from the stock house to the open-hearth furnaces, and ingot cars from the furnaces to the rolling mill.

(E) All tracks at this new plant are of standard gage, with the exception that 36-in. tracks were laid for handling ingots from the pouring pits to the soaking pits, as there was insufficient clearance for standard-gage equipment.

(F) Of three old plants, two have 28-in. and 32-in. respectively, while the other has 30-in. and 36-in. tracks in two different departments. All these are continued in use because there is no advantage in introducing uniformity, since they are disconnected lines so that cars could not be interchanged. At these old plants it would be impossible to install standard-gage tracks through the works. Of the four gages in use, the 32-in. is considered preferable for the class of work, the equipment being flexible, easily handled and wide enough to prevent spilling the loads.

ELECTRIC LOCOMOTIVE AT COPPER WORKS
Narrow-gage storage-battery engine hauling 50 tons of copper plate.

Bridge and Structural Plants—Of nine bridge and structural steel plants, one has standard gage throughout, three have 30-in. tracks and one each has 22-in., 24-in., 26-in., 28½-in. and 36-in. The one having the 24-in. gage would use 30-in. if building the plant anew, while the one having the 26-in. gage would consider trucks preferable to cars under the same circumstances.



LARGE PLANT LOCOMOTIVE
Standard-gage steam 105-ton 2-6-0 engine with tender.

All these plants have standard-gage railway connections, and at least one of them operates plant cars on these tracks as well as on the narrow-gage tracks.

Industrial Plants, Mining and Logging

Machinery Plants—A builder of heavy machinery reports the foundry equipped with tracks of 21½-in. gage measured outside the rail heads, the car wheels having outside flanges. A number of foundries and similar works have used this type of industrial railway for handling ladles, molds and castings, but one of these plants states that cranes and overhead monorail carrier systems can give more rapid operation. At the plant in question, standard-gage industrial tracks are considered preferable where there is room for them, so that locomotive cranes could be used and railway cars could be run into the buildings. Another company of the same character has the entire plant served by standard-gage tracks, handling raw materials and finished products. A third company, which had originally some 36-in. tracks, has removed these and has adopted standard gage for all tracks in its shops, mills and yards. And a fourth company reports the use of standard gage exclusively, with depressed tracks in the buildings.

On the other hand, a large machine building concern adopted a track system of 24-in. gage for its new works, supplementary to the standard-gage connections and sidings in the plant. This selection was based upon clearances, less expense for construction and equipment, and less occupied space where the tracks are laid along or across the roadways of the plant. Again, a chemical company has tracks of 36- and 30-in. and narrower gages at its different plants, and as these lines are not connected there is considered to be no object in converting them to a uniform width. But in general for its plant service this company favors 36-in. and 30-in. for handling heavy and light loads respectively.

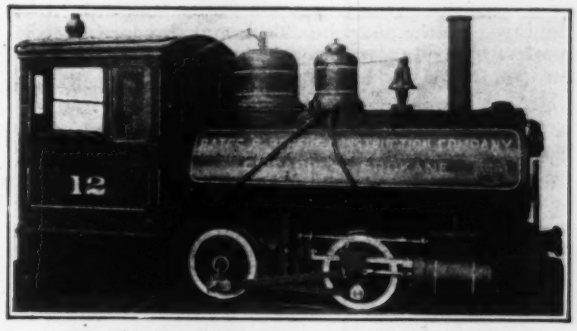
Electrical Plants—Of three large electric manufacturing works, all with standard-gage railway connections, one has standard gage and the others have narrow gage for the industrial or plant railways. Of the two latter, one has 22-in. and the other 36-in. gage for these lines. No reason is known for the particular gage adopted in either of these cases. In the plant having the 36-in. gage, the cars have a maximum width of 5½ ft. and are operated on elevators and on the upper floors of the buildings. At this plant, with a site of 300 acres and a total floor area of 140 acres, the industrial railway system handles about 8,000 tons daily. But at its newer and smaller plants, this concern does not install industrial tracks, preferring to utilize tractors, trailers and motor trucks for inter-department service.

Quarry and Cement Plants—For quarry, gravel, sand and cement plants, both narrow- and standard-gage service tracks appear to be used in about equal proportions, but with a tendency to adopt the latter for modern installations. Practically all such plants have standard-gage railway connections for shipping their products, but standard-gage tracks for the quarry or plant service are, as a rule, used only by the small four-wheel cars which carry the quarry rock to the crushers.

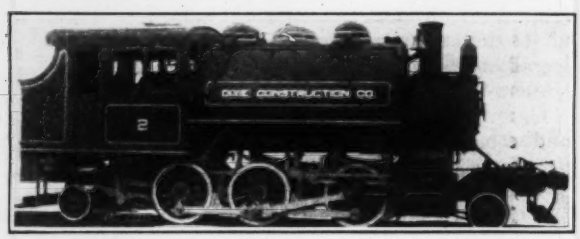
Of fourteen plants of this class, six report standard-gage and eight narrow-gage for the quarry tracks. Most of the latter are of 36-in. and 42-in. gage, while in some cases a third rail is laid along the standard-gage sidings at the surface. One company states that its 36-in. track system for quarry and plant is unsatisfactory and that it would advise the use of standard gage.

Tie and Timber Plants—Of ten tie and timber treating plants, one has all tracks of standard gage, even for the tie trams and retorts or treating cylinders. This is a modern plant having retorts of the unusually large diameter of 8 ft. Of the others, three have 30-in. gage for the tie handling tracks and one each has 36-in., 24½-in., and 24-in. while three simply state that they have narrow-gage for these tracks. All the plants have standard-gage railway connections, and the nine which use narrow-gage plant tracks have three-rail mixed gage tracks through the tie storage yards. In plants of this kind the gage for the tie trams is governed largely by the diameter of the treating cylinders, but no good reason is apparent for the ½-in. variation noted.

Mining and Logging—Although narrow-gage tracks in mines are necessary on account of the limited size of passages, there is considerable variation in actual widths of gage. These have been listed in the paragraph on plant railway equipment. As noted already the American Mining Institute has sought to standardize the 42-in. gage and to provide that where other gages are used they should vary by 6-in. increments. For logging railways, both standard-gage and different narrow gages are used, the latter being mainly 36- or 42-in. Strong arguments in favor of standard gage are given in an article in *Engineering News-Record* of March 12, 1925, p. 442. The conclusions presented were that while it could not be said that either standard gage or narrow gage should always be used, yet in a great majority of cases a standard-gage line is more efficient



CONTRACTOR'S NARROW-GAGE LOCOMOTIVE
"Dinkey" engine of 8 tons weight for 3-ft. gage.



LARGE LOCOMOTIVE FOR CONSTRUCTION WORK
Standard-gage 50-ton 2-6-2 engine.

and more economical. Narrow gage should be used only where demanded by special conditions, and these apply almost entirely to the cost of grading.

Industrial Construction Railways

Railways on Construction Works—For railways used on engineering construction works a wide range of gages is noted by different contractors and engineers, including 18, 24, 30, 36, 42 and 56½ in., the variation being due in part to different classes and conditions of work and in part to difference of personal opinions. In general, however, opinions appear pretty well agreed that the three widths of 24-in., 36-in. and standard gage will meet the varying requirements for different kinds of construction work, with the exception of tunneling, for which narrower gages may be suitable.

A railway engineer states that 36-in. tracks are employed on company construction work, except that 24-in. tracks are used in driving tunnels. An engineer on dam and hydro-electric work says that standard gage is the most satisfactory on extensive excavating and concreting jobs. Five large contracting firms give their preferences as follows: (1) We use two widths almost entirely, 36-in. and standard-gage; (2) we use various widths on different jobs, from 18-in. to standard-gage; (3) we use 18-in. and standard gage as a rule; (4) we use 36-in. mainly, and standard-gage only when ordinary railway equipment is to be handled, but for tunnel work we use 24-in. with mule haulage and 20-in. where cars are pushed by hand; (5) the 30-in. gage is practically our standard, except that we use 24-in. industrial track with 1-yd. cars for delivering sand and gravel to concrete mixers and sometimes for carrying concrete from the mixer to the place where it is to be deposited.

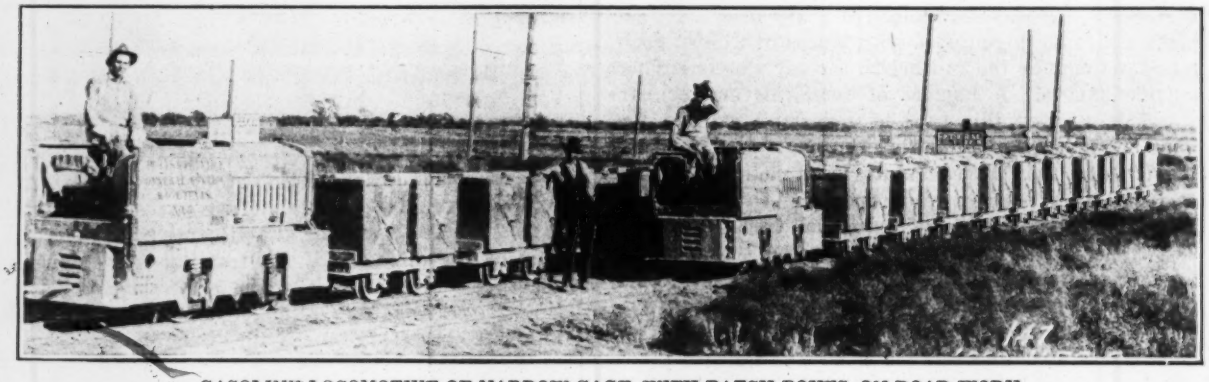
For industrial railway haulage on such a specialized class of construction work as road building, the 24-in. gage is practically universal, and in most cases portable track is used for this gage. In one case where 36-in. track was used, it is said to have added materially to the contractor's cost, owing to the extra width of shoulder that had to be built to carry the wider gage.

Practice and Opinion—Responses to inquiries as to the widths of track gage used and preferred for different classes of construction work may be summarized as follows:

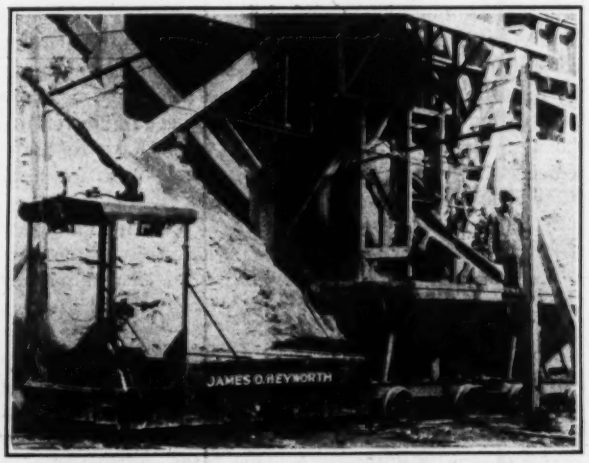
(A) For standard-gage: (1) On extensive and heavy work; (2) for long hauls or where work is accessible from operated railways; (3) for bank widening and double tracking on operated railways; (4) where yardage is more than 150,000 cu.yd. and haul is more than two miles.

(B) For 36-in. gage: (1) With 2- or 3-yd. power shovels; (2) where yardage in pit or cut is 15,000 to 150,000 cu.yd. and the haul does not exceed two miles; (3) for hydro-electric and bridge work; (4) for light and medium work in general; (5) both 36-in. and 42-in. gage are suitable where 4- or 5-yd. dump cars are used, where the work is not accessible for standard-gage railway equipment, or where the haul is less than two or three miles.

(C) For 24-in. gage: (1) On road work and paving; (2) for hand haulage and tunnel work; (3) for grading where small revolving shovels are used; (4) for trapping and small power shovel work in connection with 1- to 1½-yd. dump cars; (5) where the excavation is less than 15,000 cu.yd. and the haul is not more than 2,000 ft.; (6) for road and gravel pit work. Another case is where the track can be laid along the shoulder of a railway subgrade for handling excavation and concrete, as noted in regard to the construction of the



GASOLINE LOCOMOTIVE OF NARROW GAGE, WITH BATCH BOXES, ON ROAD WORK



ELECTRIC LOCOMOTIVE HANDLING CONCRETE
Narrow-gage trolley engine with hopper cars.

Calumet River bridge of the Illinois Central R.R. in *Engineering News-Record* of Oct. 21, 1926, p. 669.

Conclusions on Industrial Railways

Based upon the information given as to actual practice, broad conclusions appear to be warranted:

(1) In general, standard gage is preferable for plant railways, where its use is practicable.

(2) For certain kinds of plant service, narrow-gage tracks are suitable or even necessary.

(3) In many cases the use of narrow-gage trackage for the general plant system is made necessary by topographical, property or layout conditions.

(4) Although these narrow-gage lines are isolated and independent, there are reasons of economy and convenience which make it desirable that the widths of gage should be reduced to a limited number.

(5) Where both standard-gage sidings and narrow-gage industrial tracks are installed, it will be convenient to lay a third rail along the former so as to extend the circulation of narrow-gage equipment.

(6) Standard-gage tracks may be operated exclusively by plant or both plant and railway equipment.

(7) For engineering construction work, the three gages of 24-in., 36-in. and 56½-in. appear to meet all requirements, except that narrower gages may be advisable in tunneling or under special conditions.

Iowa Flood of Cloudburst Type Damaged River Structures

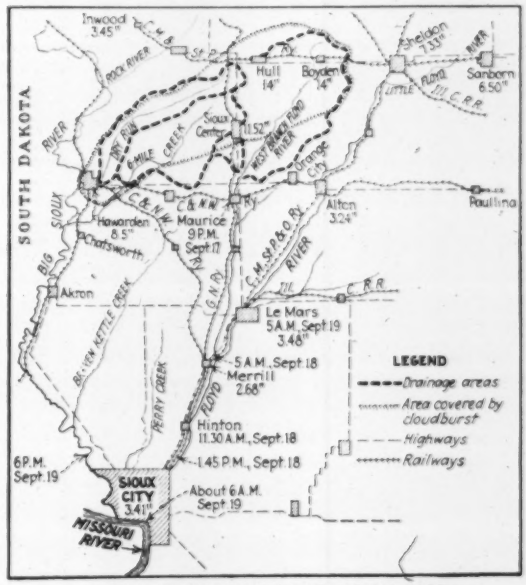
Small Streams Caused Much Damage in Towns and to Railway and Highway Fills and Bridges—Rainfall Records

THE serious and disastrous floods that may occur even on small streams, due to sudden heavy rainfall, are illustrated by a report on the flood in Sioux County, Iowa, on Sept. 17, 1926. Of this report by E. W. Dunn, district engineer of the Iowa State Highway Commission, at Sioux City, an abstract is given below. Space does not permit including detailed accounts of the great amount of damage to private and public property, but the flood effects at bridges indicate the importance of liberal waterway openings and the necessity for substantial types of structures. The accompanying map shows the area covered by the storm, the streams affected and the time it took the floods in the various valleys to reach certain points and finally pass into the Missouri River.

At about 2:30 p.m. [Sept. 17, 1926], a rain began over a limited area in Sioux County, increasing in intensity and continuing until 4 a.m. Sept. 18. At times it apparently equaled heavy tropical storms. Small watersheds of a few acres discharged streams, while Six-Mile Creek, Dry Run and the West Branch of the Floyd River discharged torrents of water of such depth and volume as to destroy almost everything except the most substantial construction work. Beginning near Hawarden, where a rainfall of 8.5 in. was reported, the storm extended over Sioux Center (11.52 in.) and to Sheldon (7.33 in.). Official records are not at hand for the communities around Hull and Boyden, but the most conservative estimate seems to be 14 in. between 2:30 p.m. and 4 a.m.

The topography is flat in the vicinity of Boyden, but becomes rolling near Hull and Sioux Center and then hilly towards Hawarden, with 6 per cent grades common on the improved highways. Thus the tendency of the topography was to minimize flood conditions, as water falling on the lower end of the drainage area would be passing on before being augmented by the main flow from the flatter sections. The whole area is highly cultivated farm land. The storm moved from southwest to northeast and passed almost directly up the valleys of the three streams mentioned.

At Hawarden the town is built up around Dry Run and two of its streets cross the stream. The drainage area of 31,000 acres is 20 miles long and two to four miles wide, and ordinarily such a long and narrow watershed would minimize flood conditions. Over two concrete bridges, including a two-span structure about 60 ft. long, the water was several feet deep. From the second bridge to the Sioux River the flood cut through a terrace of sand and gravel so that the old channel 25 to 100 ft. wide became 300 to 400 ft. wide. Several houses near the old banks were undermined and carried away. A light steel street bridge was wrecked and its abutments of concrete and its cylinder piers were undermined and collapsed. The situation here is an example of the rapidity with which a small stream in flood can scour out an almost unbelievable amount



IOWA FLOOD OF SEPT. 17-18, 1926

of material. One life was lost and the damage to homes, business and other property is estimated at $500,000.

Six-Mile Creek does not pass through a town, and the damage was confined mainly to farms, roads and bridges. On a road crossing the stream by a 60-ft. skew arch concrete bridge, 15 years old, the water was 6 ft. deep. Scour caused one abutment to settle and the arch to crack, so that the structure is practically a total loss. This stream has a drainage area of 47,500 acres, about 75 per cent of which was in the section of heaviest rainfall. Runoff from Dry Run and Six-Mile Creek drainage areas raised the Sioux River to flood stage, but it was not unusually high and did little damage between Hawarden and Sioux City. The crest of the flood on both creeks passed into the Sioux River before midnight of Sept. 17 and reached Sioux City late in the evening of the 19th.

Sweeping from Sioux Center to Boyden the storm covered some 80,000 acres of the upper portion of the drainage area of the West Branch of Floyd River. Rainfall was intense over 75 per cent of this area and the flood in the Floyd valley at Sioux City exceeded all records except that of 1892, which was 2½ ft. higher. The flood moved with great rapidity, rising in waves of 6 to 24 in. as successive obstacles gave way. At the junction bridge near Orange City, the flood crest arrived about 9 p.m. Sept. 17, and was receding at midnight. A bridge which we were building 3½ miles below was reached between 10:30 and 11 p.m. At 5 a.m., Sept. 18, the flood crossed the road north of Merrill and washed out the Illinois Central R.R.; at 11:30 a.m. the road east of Hinton; and at 1:45 p.m. the road running east from James. Thence it slowed down, and the peak reached the Westcott St. bridge in Sioux City, about 6 a.m. Sept. 19.

East of Boyden the storm was less intense, with 7.33 in. at Sheldon and 6.5 in. at Sanborn. As the runoff descended

the main branch of the Floyd River 12 to 24 hours behind the flood in the West Branch it did not cause a rise equal to that of the previous day. Washouts of trestles and fills occurred on the Great Northern Ry. and Chicago & Northwestern Ry. and the highways, while at the site of a new highway bridge the scour was 15 ft. deep and the 60-ft. channel was widened to 170 ft.

Attention should be drawn to the fact that the only bridge of modern type that was damaged was a 28-ft. I-beam span with concrete floor and abutments and 16-ft. foundation piling. This was undermined and collapsed. Timber trestles, pin-connected truss spans, concrete arches and other lighter types were almost completely lost, except in a few cases. At no place was the waterway of either the highway or railway bridges adequate to carry the flood flow. Highway and railway fills and farm fences, clogged with drift, checked the rush until they gave way successively, permitting the flood to sweep on to the next obstruction. It is impossible to estimate waterways sufficient for such emergencies, but it should be possible to build structures and foundations that will be unharmed even if submerged by flood.

Erecting a High-Head Penstock on the Balch Project

Gantry Places Pipe Sections on 60-Deg. Slope—Total of 1,328 Tons of Pipe Assembled on Steep Profile in Four Months—Design Adapted to Conditions of Local Sections of Pipe

THE Balch project of the San Joaquin Light & Power Corporation, located 30 miles east of Fresno, Calif., is notable because of high head, 2,381 ft. static, and because it introduces in the United States banded pipe, a type consisting of a forge-welded core over which steel bands are shrunk on. Banded pipe has been used rather extensively in foreign high-head developments. The construction methods used on the Balch job are noteworthy; a structural steel gantry expedited erection of the penstock on extremely steep slopes and the organization of the field work as a whole made possible very high speed erection. Outstanding features of the field work are reviewed in the following. A description covering the penstock design accompanied by drawings of joints, anchorages, specials, etc., appeared in *Engineering News-Record*, Nov. 18, 1926, p. 836.

The selection of banded pipe for this job was made on a price and quality basis and the Ferrum Co. of Poland was considered to have submitted the best proposition for a penstock guaranteed to meet the specifications laid down by the power company. An examination of the pipe in place, where successive sections can be readily compared, makes it apparent why it was possible for this manufacturer to bid as he did. Each section of the pipe line was individually designed; that is, the dimensions and spacing of bands, core thicknesses and the type and strength of joints were adapted to the location of each individual section. Thus there was secured the full protection of the specified safety factor without any extra metal in places where it would not add to the net strength of the penstock as a whole.

By this it is not meant to imply that the design seems to have been "skinned down"; rather the contrary impression is created by flanges 4 and 5 in. thick which occur in the section near the power house where the heaviest metal is used. It is here that the frequency in change of design is specially notable. To make the joint between abutting sections in this part of the line, two of these flanges, making a total of 9 in. of steel measured longitudinally with the pipe line, are drawn up together by 2½-in. bolts.

Just why the design changes as it does is best known to the manufacturers. They frankly admit that certain stresses in banded pipe are mathematically indeterminate. The empirical determinations, however, are supported by experience with pipe actually in service in various countries and thus the manufacturers confidently give a blanket guarantee covering defects that may develop as the result of faulty erection as well as those due to imperfections of material or fabrication.

The longitudinal seams in the cores of the pipe sections were hammer forged and then the section was rolled at annealing heat. The result is that it is difficult to find the weld in the core. The ends of those sections on which butt-strap joints are used were turned in a lathe to exact dimensions, as were the bands to go over them, so that erection in the field was a matter of

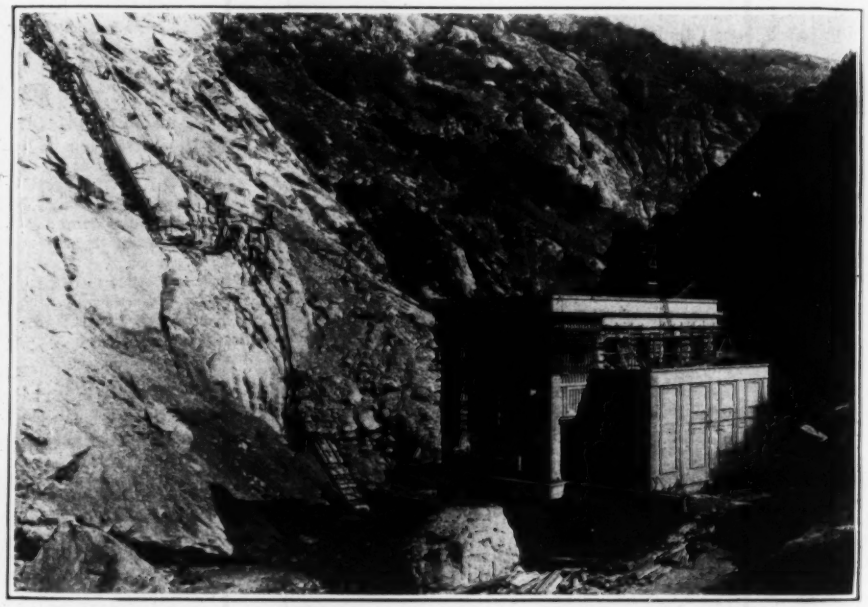


FIG. 1—BALCH POWER HOUSE AND PENSTOCK UNDER CONSTRUCTION
Very little water was flowing at this time. Note concrete foundations for penstock in stream bed.

assembling machined fits. The use of angle distance pieces at the more difficult of the heavier joints facilitated correction of slight deviation from exact alignment.

The Balch penstock is 4,882 ft. long with diameters decreasing by 4-in. steps from 60 in. at the top to 40 in. at a point 300 ft. from the power house where a Y splits the line into two 34-in. pipes leading to the nozzles of the 40,000-hp. double overhung impulse wheel.

A road built as part of the construction project intersects the penstock at its midpoint in both distance and elevation and this point was made the camp site and depot for delivery of all pipe sections excepting only those for the 300 ft. nearest the power house which were delivered from that end. A standard-gage incline railway operated by a hoist at the top and controlled by a signal system, served the upper 3,900 ft. of the penstock. From a loading depot at the road intersection, pipe was delivered on the incline car to all points along the upper 3,900 ft. of the line. The sections were rolled from the car onto the temporary timber supports while held by cables to one of the concrete piers above. For the 1,100 ft. below the incline, sections were delivered to a platform at the bottom of the incline.

From this platform as a loading depot a gantry was used to deliver sections for that portion of the penstock below, where the slope varies up to a maximum of 60 deg. and averages 45 deg. for the entire 1,100 ft. This gantry, shown in the accompanying pictures, was built of structural steel and operated on a track of 8-ft. gage. The track was supported on trestle work built on the rocky slope which had been carefully blasted out not only to provide a firm footing for the concrete anchors and piers but also to remove all material that might at some later time loosen and fall on the penstock.

The gantry was 18 ft. long, allowing both ends of the 20-ft. sections to project, and was equipped with a 4-ton chain block on each corner with which the pipe sections were handled within the gantry. The wheels were double flanged, 14 in. in diameter. The receiving platform at the foot of the incline and at the upper end of the gantry track was located at anchor No. 9, being built out as a bench or level platform supported on timbers.

The gantry track was laid flush with the platform, so that the gantry could straddle and pick up a section of the pipe delivered from the incline. The four chain blocks were then placed beneath it and across the gantry frame, after which the weight of the pipe was lowered to the H-beams. The cable was attached directly to the pipe section as well as to the structural frame itself, so there was no danger of the pipe "getting away" from the gantry.

Because of the steepness of the slope below this point it was thought necessary to provide means of taking up that component of gravity thrust that would

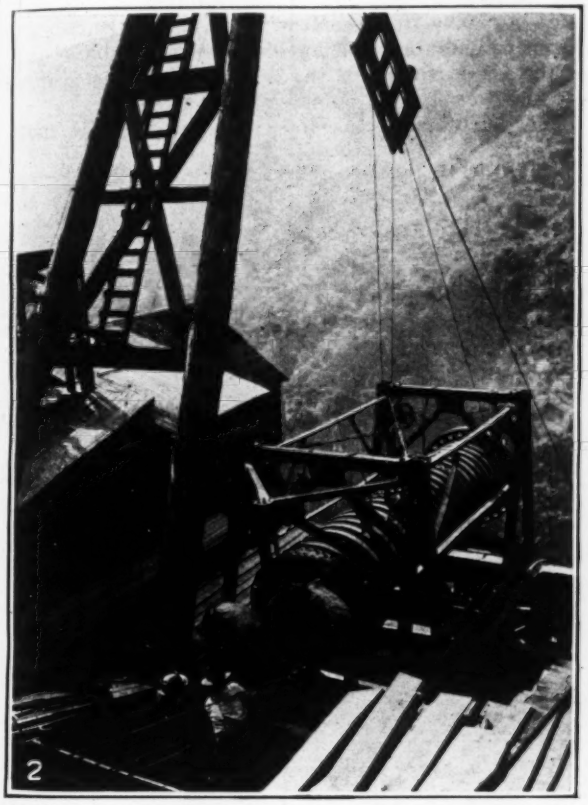


FIG. 2—GANTRY WITH PIPE SECTION RESTING ON H-BEAMS

This platform marks lower end of incline and top of gantry track. The cableway is not involved in the operation of the gantry. Note different types of joint on opposite ends of section.

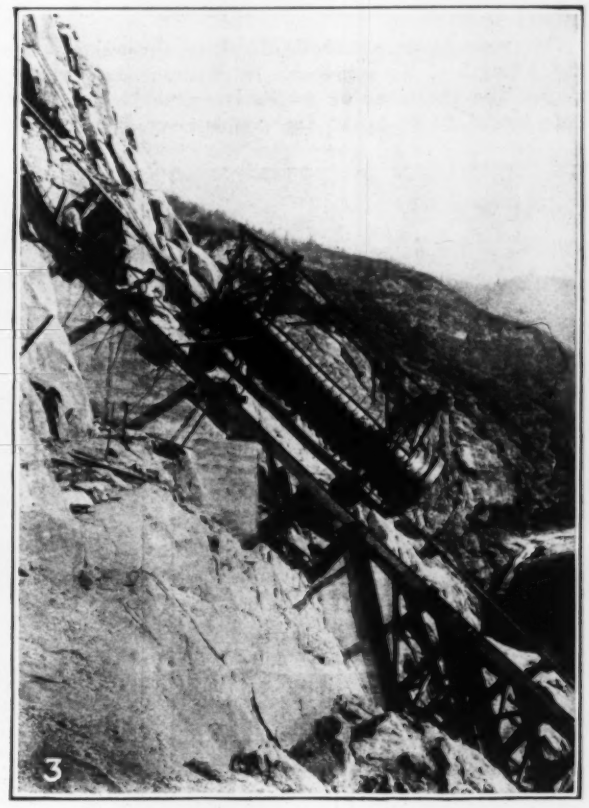


FIG. 3—FIRST PIPE SECTION EN ROUTE IN THE GANTRY

Note steeper profile above and to the left. The 8-in. pipe in background is the concrete delivery line. In the distance can be noted upper reaches at the canyon of the stream.

be transferred from pipe to piers in a direction parallel to the pipe center line. To carry this thrust, anchor rings in two semicircular halves were bolted to each pipe section that was embedded in a concrete anchor. These rings, which have a diameter sufficient to distribute the load over the necessary concrete area, were bolted around the pipe in a loose fit, just below a thrust collar that took the place of one of the bands. The collar was made somewhat thicker than the band and was double riveted to the pipe core. The anchor rings were put on in the field after the section had been riveted up in place.

The pipe sections are 20 ft. long throughout the entire length of the penstock. In all the lower portions of the line the piers on which the pipe is supported were placed 40 ft. apart, the double-riveted butt-strap joints being considered amply strong to transfer the total load from section to section between piers. Near the upper end where the diameters are larger and the pipe shell thinner, the pier spacing was reduced to 30 ft.

Where the line passes over high points in the profile, steel straps were passed over the pipe and anchored to the concrete to prevent upward thrust from lifting the penstock off its foundation. These straps, varying in size and spacing with the location in the line, terminate on either side of the pipe in a structural steel member, made up of two channels placed back to back, about 2 in. apart and fastened together with plates. The straps that pass over the penstock were bent in the shape of an inverted U, and each end was passed down between the two channels to nuts on the lower side. The channels in turn were held down by 1-in. rods anchored in the concrete and extending up between the channels to nuts on the upper side.

Generally speaking, the joint types are: Single-riveted bump joints in the sections at the extreme upper end of the line with double riveting beginning where the plate thickness reaches $\frac{1}{2}$ in. Butt-strap joints, always double riveted, begin in plate thicknesses of $\frac{3}{8}$ in. and continue to the Y, 300 ft. above the power house. Below the Y only bolted flanged joints are used. The bands begin about midway of the penstock where the plate thickness of unbanded pipe reaches $1\frac{7}{16}$ in.

The methods of riveting varied in different parts of the line; in the upper portions where the head was low the riveting gun was used chiefly inside the pipe with a 40-lb. weight held against the rivet on the outside. Some riveting was done with guns on the outside, the usual jack brace being used inside to "buck up." In the lower portion of the line guns were sometimes used both inside and outside simultaneously.

This simultaneous use of two guns was the most satisfactory driving method, using the outside or bucking-up gun in connection with a 40-lb. weight. Only enough blows were struck with the outside gun to aid in properly drawing up the rivet. For the most part the rivets were driven from the inside to avoid passing hot rivets into the pipe, and, in the butt-strap sections, to gain the advantage of driving against the lighter plate.

On the lower portions of the line the pipe is flanged and bolted, the bolt diameters varying from $1\frac{1}{4}$ to 3 in. Four different standards of threads and three different kinds of steel are used. The German thread standards are used in the bolts of the upper flanged sections and a very fine special thread on the bolts under the highest head. The special steel, making possible smaller bolts, saved in the necessary flange widths and the finer threads made it possible to secure more initial tension with less shock from bolting up.

The final tightening up of nuts on the bolted joints was intended to get exactly uniform tension in the several bolts of each joint. Each bolt was tested by a

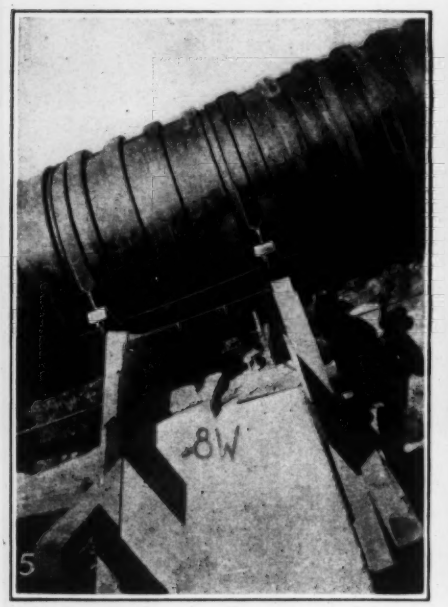


FIG. 5—SLIP JOINTS UNDER PIPE ON PIERS

Note rail grillage. The two plates afford smooth surface for sliding under expansion stresses. Space between bands above plate will be filled with asphalt to prevent accumulation of water.

FIG. 6—AN EXAMPLE OF INTERNAL RIVETING

The gun is on the inside, bucker-up holds weight against rivet on the outside. There is always considerably more than the length of one complete section between concrete supports.

superintendent with long experience in making such joints on high head penstocks. His method of judging the tension was to tap the end of the bolt with a light hammer used solely for purposes of sounding. This test, depending upon the "musical ear" of an expert was the sole and final test of tension in each bolt and with this as a guide the nuts on bolts found slightly below the desired tension were turned up as much as the sound of the testing hammer indicated was necessary.

The concrete piers or pedestals on which the pipe is supported were finished to a level 4 in. below the underside of the pipe. This was to allow for any discrepancies in field engineering and to take up any minor

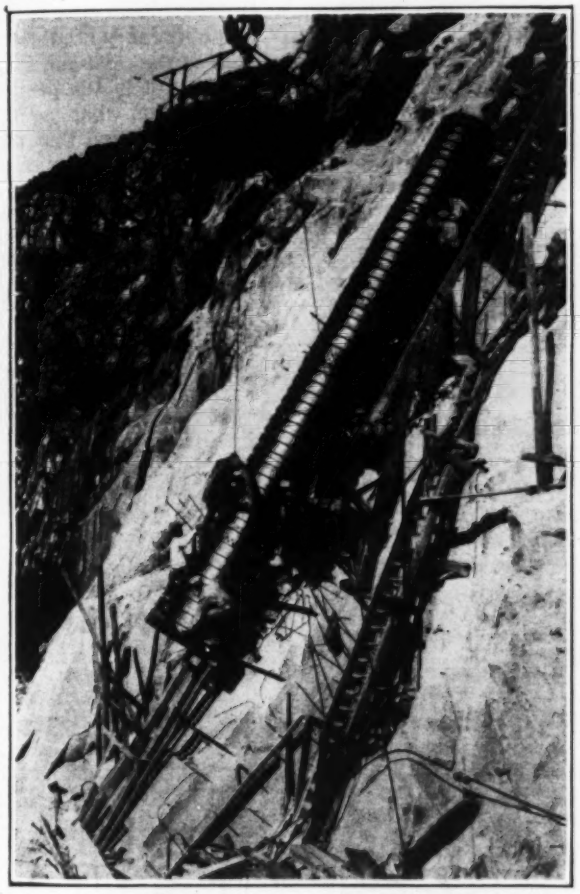


FIG. 4—PLACING ANCHOR RING ON THE BANDED PIPE
Upper half of anchor ring is being lowered from cableway. Note the riveted collar against which ring will brace. This is at anchor 14 where the Y goes in.

deflections that might be incidental to getting the pipe into place. The pipe was riveted up while the weight was carried between piers on temporary timber cribbing and, on the piers themselves, by grillages of short pieces of railroad iron or other scrap metal that could be used to wedge the pipe up to line and grade. Forms were then placed around the tops of the piers and 4 in. of concrete was poured, embedding such metal as had been used for supporting the pipe. The field engineering checked out so closely and the alignment was so good that 4 in. proved to be a greater allowance than was necessary. The pier saddles are in contact with the pipe for one quarter of its circumference.

The pipe sections were given two coats of tar paint at the factory and no additional protective coating was put on in the field except that all butt-strap joints were coated after the riveting was done and where the factory coating had been damaged in transit or erection, it was renewed by a "touching up" paint gang.

From the power house to a point on the penstock about 250 ft. up the steep bluff the line was solidly embedded in concrete. This was done quite as much to protect the pipe from damage by falling rock as to constitute an anchor. This concrete as well as that for piers in the lower portion of the line was mixed near the upper end of the gantry track and from that point was delivered by gravity in a 6-in. pipe for drops of as much as 1,100 ft. down the steep slope below.

All of the pipe in this penstock was fabricated by the Ferrum Company, of Poland, and was erected in the field by crews employed by the power company. Construction of the Balch project was under the general supervision of Harold K. Fox, construction superintendent, San Joaquin Light & Power Corporation.

Separate Digestion Tanks and Sand Filters for Wheaton Sewage

WITH sewage effluent discharge into a stream which is practically dry during a considerable part of the year and which flows through some fine suburban private estates, a high degree of treatment is provided by the sewage-works now being built at Wheaton, Ill. This is effected by supplementing the tank treatment with intermittent sand filtration. The present population is about 5,000, but the sewage-works have been designed on the basis of treating 1 m.g.d. of sewage from a population which is estimated to reach 25,000 between 1935 and 1940. For operation on the separate sludge digestion system, there are two settling tanks and two digestion tanks; the two digestion tanks have a holding capacity of 27,000 cu.ft. and the settling tanks provide a normal detention period of 3½ hours for a sewage flow of 1 m.g.d.

The settling tanks are square, with bottoms nearly flat and having conical sumps. Solids are collected by Dorr clarifiers and raised to the digestion tanks by motor-driven pumps. Sludge removal may be continuous or intermittent, as the conditions of the sewage may indicate to be advisable. The digestion tanks have facilities for removing the surplus water, and the water of liquefaction from these tanks may be drawn off over a weir and returned directly to the settling tanks. If heavy scum forms on the digestion tanks, the liquid between the scum and the sludge may be piped back to the pump suction and passed through both tanks again. Three acres of intermittent sand filters are now completed and a fourth is to be built at once. With four acres provided and one acre of this area out of service for cleaning, the rate of filtration will be 166,600 gal. per acre per day at present. These sewage-works were designed by Alvord, Burdick & Howson, consulting engineers, Chicago.

Arthur L. Webster is chief engineer of the Wheaton Sanitary District, for which these works are being built.

Railway Construction in 1926

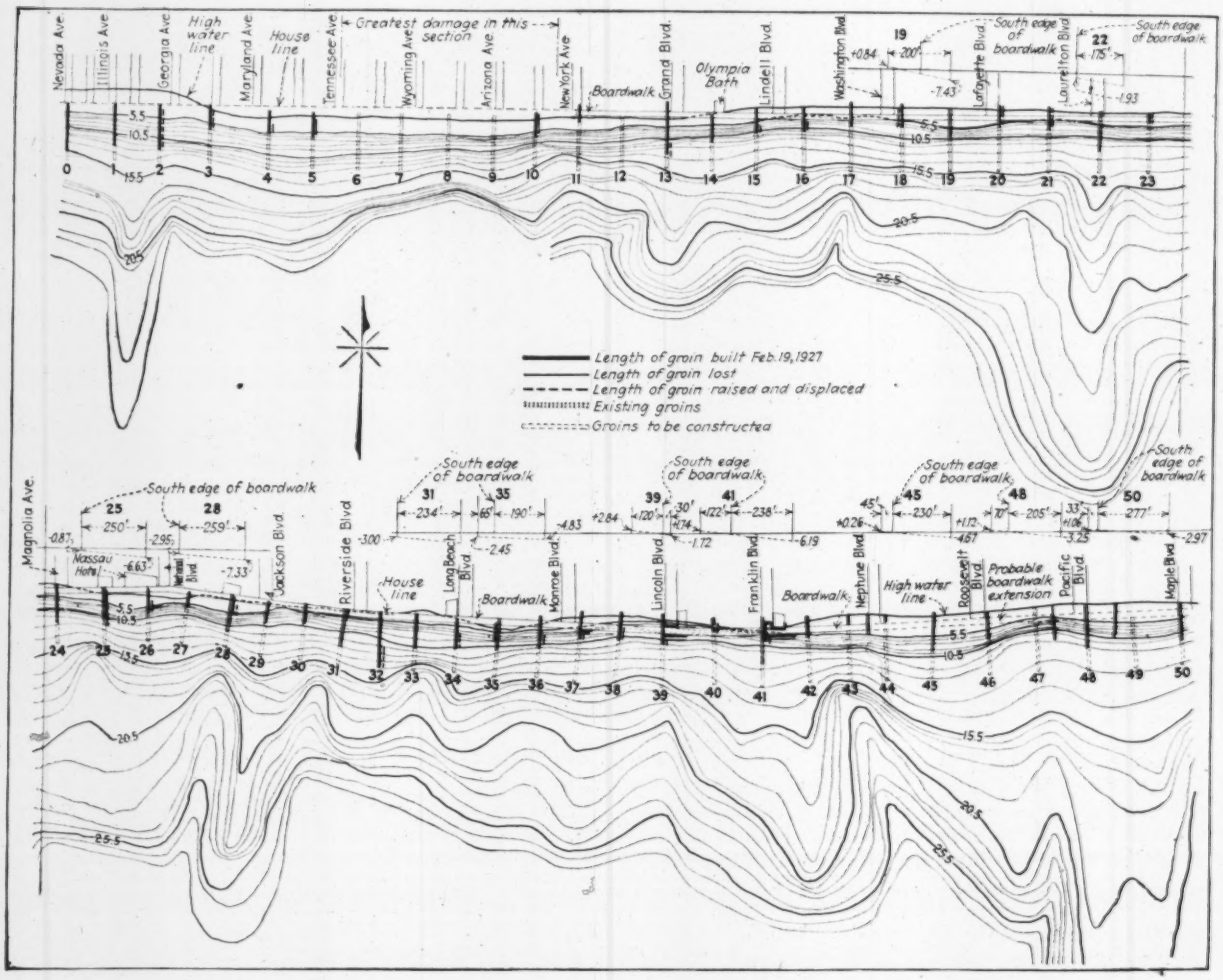
On the map of the United States published in our issue of Feb. 24, p. 314 it was stated that the Northern Pacific Ry. was building the Cascade Tunnel. This statement was in error. The Great Northern Ry. is building the tunnel.

Shore Protection Works Damaged by Heavy Seas

Groins at Long Beach, L. I., Under Construction, Suffer $75,000 Extent—Heaviest Property Loss Occurred at Unprotected Stretch of Waterfront

EXTRAORDINARY high tide and heavy seas resulting from a northeast gale that at times attained a velocity of 70 miles per hour on Feb. 19 and 20 did considerable damage to the shore-protection works under construction at Long Beach, Long Island. The damage to actual shore protection works, groins for the most part, is estimated at $75,000, and the loss to business and residential property will run under fifty thousand dollars. The storm lasted from 7 p.m. Feb. 19 until 11 p.m. Feb. 20, whipped up a heavy surf and was accompanied by a tide 5½ ft. above mean high water. The high tide with the resulting inland wash, encroached for considerable distances northward of the Long Beach shore line.

In general the shore-protection work along the three-mile stretch of principal Long Beach beach consists in pile and timber groins placed on 350-ft. centers and extending an average of 400 ft. seaward. Construction of them was started in October, 1926, when an appropriation of approximately $800,000 was made for the work. During preceding years a few low pile groins had been built at the expense of owners of beach property. Because of the constant encroachment of the high-water line upon valuable property plans were made to protect the whole beach. The preliminary studies to design included float investigations of the tidal and current directions. The controlling feature in the design was discovered to be the determination that action normal to the shore line was the greatest, and that the greatest natural sand fill would result from building groins perpendicular to the shore line. Some bulkheading would be necessary where the sea had en-

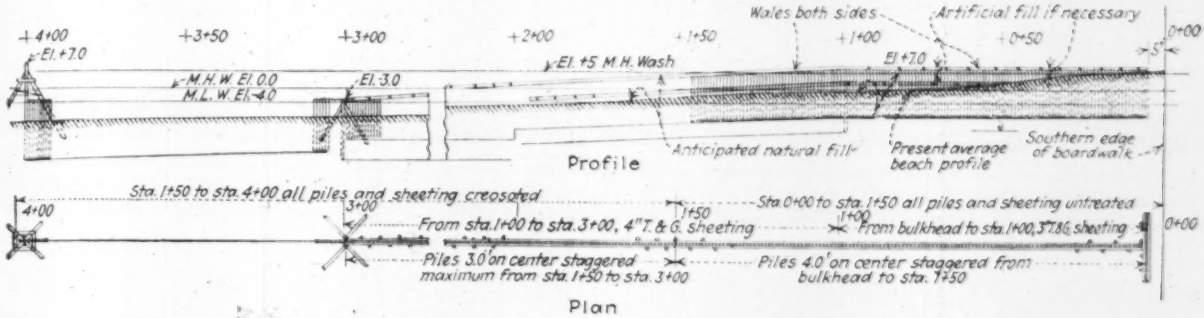


PLAN OF SHORE PROTECTION WORK UNDER CONSTRUCTION, SHOWING STORM DAMAGE

Contours indicate soundings made last year before construction started—shown here only as indication of general beach irregularity. Numbered profiles refer to existing groins. High-water line shown is previous to storm.

croached greatly on shore-line property, but the principal structures for protection of the waterfront would be groins.

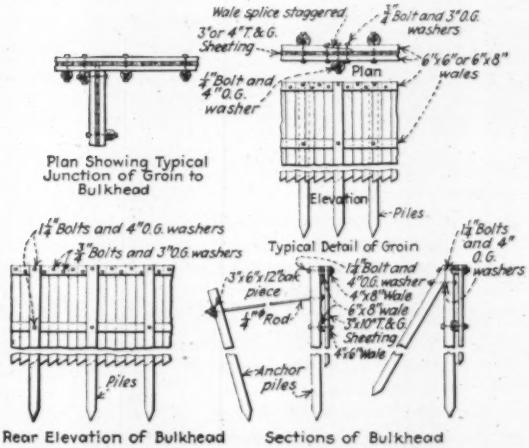
Groins are of several types, though the prevailing ones


Profile
Plan
Wales both sides
Artificial fill if necessary
Anticipated natural fill
Present average beach profile
Southern edge of boardwalk
Sta. 1+50 to sta. 4+00 all piles and sheeting creosoted
From sta. 1+00 to sta. 3+00, 4" T. & G. sheeting
Piles 3.0' on center staggered maximum from sta. 1+50 to sta. 3+00
Sta. 0+00 to sta. 1+50 all piles and sheeting untreated
From bulkhead to sta. 1+00, 3" T.&G. sheeting
Piles 4.0' on center staggered from bulkhead to sta. 1+50

PROFILE AND PLAN OF GROINS UNDER CONSTRUCTION FOR SHORE PROTECTION AT LONG BEACH, L. I.

are built up of 4x8-in. tongue and groove sheeting stabilized by medium size hardwood piles and 6x6-in. or 6x8-in. wales. The piles are staggered and set on 3-ft. centers and driven to an average penetration of 23 ft.; the sheeting, from 15 to 18 ft. Bolts, 1¼ in. in diameter, tie the piles through the wales to the sheeting. Wales are placed both flush with the top of sheeting and about 5 ft. lower. Three-quarter-inch bolts are used to tie sheeting and wales together. The higher groins are strengthened by the addition of batter piles and diagonal braces.

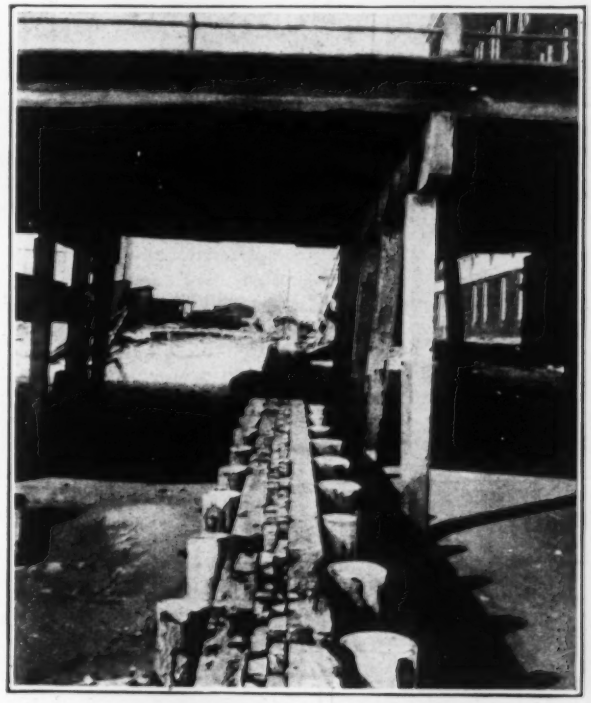
Though, as the drawing herein reproduced indicates, construction had not proceeded far except in a few cases, it is the belief of the city engineer of Long Beach, John W. Schaefer, that enough had been done upon them to hold sufficient sand to avoid great damage to shore-line property. As a matter of fact it was observed that where the groins had been carried out an appreciable length the beach was but slightly, if any, lowered, and the heavy seas did not reach or encroach upon or damage any buildings. Where groins had not been started or had proceeded but a short distance the high water reached building foundations and bulkheads. As will be seen in the plan drawing herewith the greatest damage was sustained over a 1,500-ft. length of beach where no work had been started. The city engineer,



GROIN AND BULKHEAD CONSTRUCTION DETAILS

being unable to get work started on all groins simultaneously, concentrated work where a most valuable property was located. No work had been begun along that 1,500-ft. stretch and the sea lowered the beach from 5 to 8 ft. undermining and destroying a string of 28 summer homes, ranging in value from $3,000 up.

In another stretch where no new groin construction had been started, but where existing low groins had been



TYPICAL GROIN CONSTRUCTION

relied upon to hold the beach, about 5 ft. (depth) of beach was lost, undermining the foundations of a large building. This loss of depth left the sea from 100 to 150 ft. farther inland. The foundations of this building are fortunately substantial, being constructed on reinforced-concrete piles with a penetration of more than 25 ft. This building did not reveal a crack, but an adjoining building, of flimsy foundation construction, was practically destroyed.

A survey taken immediately after the storm showed that 2,348 ft. of groins had been lost or damaged and 640 lin.ft. of bulkheads. Twenty-two of them will have

to be rebuilt either partially or entirely. The survey showed the following conditions:

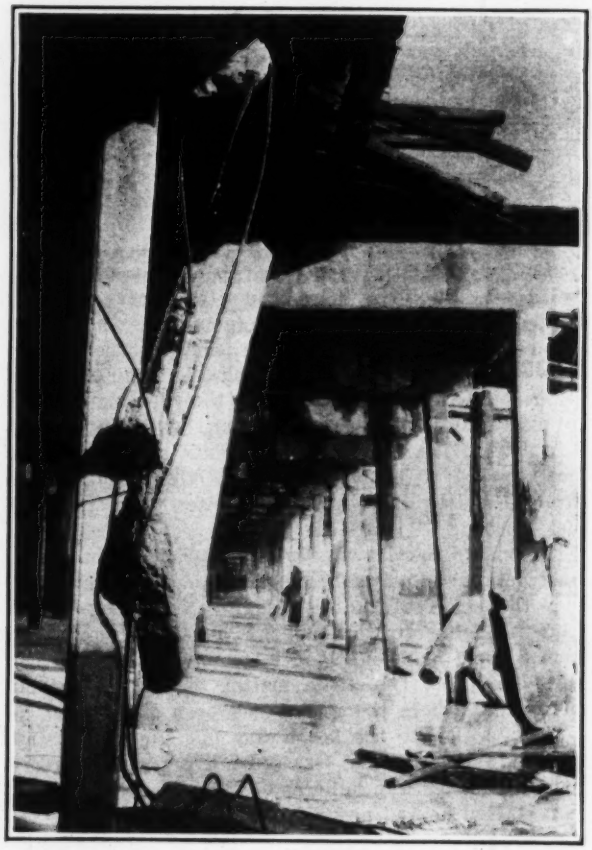
Groin No.	Condition	Portion Damaged	Lin. Ft. Damaged
2	Raised and out of line 20 ft. lost	Sta. 0—20 to +274	294
3	Rest is raised and out of line	Sta. 0+ 60 to 1+80	120
4	Lost	Sta. 0+ 95 to 1+33	38
5	Completely lost	Sta. 0— 8 to 1+89	197
10	Lost	Sta. 0— 40 to 1+33	173
13	Raised and pushed over	Sta. 2+ 10 to 3+02	92
15	Lost from Sta. 0+86 out; raised from 0+80 to 0+86	Sta. 0+ 80 to 1+44	64
16	Raised and twisted	Sta. 0+ 20 to 0+81	61
18	Raised and out of line	Sta. 0— 98 to 0—55	43
	Last 30 ft. of sheeting battered through at bottom wale	Sta. 0+ 00 to 1+08	108
20	Raised and out of line	Sta. 0—110 to 0+50	160
21	Raised from (rest lost)	Sta. 0— 95 to 0+10	110
23	Raised	Sta. 0— 50 to 0+00	50
26	8 pieces sheeting lost and 20 ft. raised between	Sta. 0+ 20 and 0+50	20
28	Raised and out of line	Sta. 0— 18 to 0+30	48
32	Lost from Sta. 2+50 to 3+01	Sta. 2+ 50 to 4+00	150
	Pushed out of line from 3+00 to 4+00, cluster at 4+00 gone.		
34	Raised and will have to be replaced	Sta. 0— 19 to 0+40	59
36	Lost	Sta. 0+ 24 to 1+29	105
37	Raised from 0—35 to 0—10; the rest is lost	Sta. 0— 35 to 0+50	85
38	Raised from 0—60 to 0—40; the rest is gone	Sta. 0— 60 to 0+45	105
39	Lost	Sta. 0+ 00 to 1+93	193
40	Raised and will have to be replaced	Sta. 0— 50 to 0—02	48
41	Raised and will have to be replaced. Last 20 ft. lost	Sta. 0+ 35 to 0+60	25

A survey was also made to determine, if possible, any variation in amount of damage to low groins as compared with the higher ones. Out of 3,650 lin.ft. of groins 5 ft. or more out of the sand at the time of the storm the loss was 1,272 lin.ft.; whereas out of the same lineal footage of groins less than 5 ft. above the sand 1,120 lin.ft. were lost or damaged. The conclusion which Mr. Schaefer reaches is that for this beach there would appear to be little choice between the low or the high groin, though one storm could not be considered entirely convincing. Of 24 groins with the free end high 11 were damaged; and out of 14 groins with the free end low nine were damaged.

The Long Beach boardwalk also suffered through both wave action and the piling against it of debris. The boardwalk has been repaired on other occasions, as since its construction the high water line has encroached on the beach several hundred feet in places. During a heavy storm last summer several sections of it were taken out by undermining of the supporting

FAILURE OF BOARDWALK SECTION THROUGH UNDERMINING OF PILES

piles. The boardwalk is 50 ft. wide supported on 10-in. reinforced-concrete piles spaced 10 ft. laterally and 15 ft. longitudinally. Reinforced-concrete girders carrying the floor system are 8 in. wide by 24 in. deep. The floor system consists of 4x14-in. joists supporting 3x6-in. planks laid almost flush upon which is laid a 2-in. slab of cement concrete. Piles are reinforced with ⅜-in. square deformed bars set 3 in. from one face and 2 in. from the other face. Reinforcing on both piles and girders has weathered badly, in many places steel not only being bared but badly corroded. When the boardwalk was first constructed piles had an average penetration of about 18 ft., but so much of the beach



BOARDWALK GIRDER BROKEN THROUGH FAILURE OF THE SUPPORTING PILES

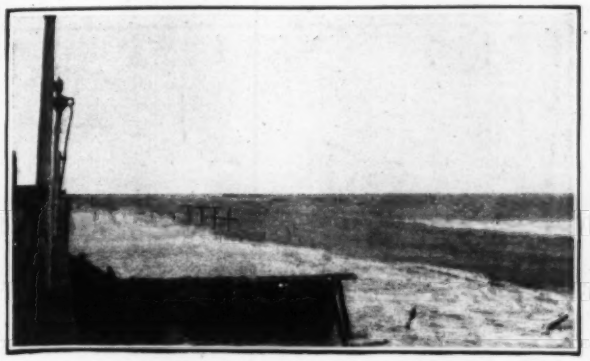
has been lost that in many places this has been appreciably reduced. The weakened condition of the boardwalk is general. Repairs are being made and it is hoped that considerable strength will be added with the completion of the groins.

The original damage to groins is believed to have been inflicted principally by floating debris, and not heavy wave action. The day before the storm a heavy sea-going tugboat was cut up and set adrift by a development company operating east of Long Beach. Mr. Schaefer believes that these heavy timbers together with other debris that is constantly finding its way shoreward, tore out the east end groins and that the increased wreckage did most of the damage farther west. Almost all of the wreckage found its way to the beach at the western end of the 1,500-ft. section where there was no shore protection and where the greatest damage to shore property was sustained.

Mr. Schaefer is convinced that had not the work on the groins progressed to the extent that it had, millions of dollars worth of damage would have been done to

the chief commercial section of the boardwalk. Of the storm and its effects he has this to say:

The lesson from the storm would be that wherever groins were even partially completed, they effectively saved the buildings on the beach, and the only place where damage was done was where no groins had been commenced, or ineffective private groins had been erected.



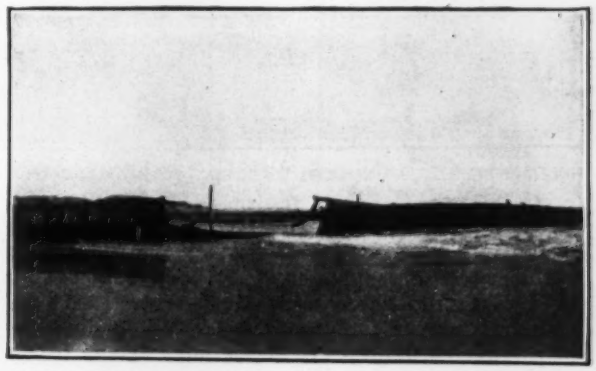
DAMAGE TO GROIN IN EAST SECTION OF BEACH AT LONG BEACH, L. I.

LOOKING WEST FROM POINT AT WHICH LEFT-HAND PICTURE WAS TAKEN

UNDERMINING OF BUILDING IN SECTION WHERE EXISTING GROINS WERE RELIED UPON TO HOLD BEACH

About 5-ft. depth of sand was lost in this short section. The left-hand view shows a building with reinforced-concrete pile foundation in which not even a crack was found. Right-hand building is badly damaged because of inadequate foundation.

CHARACTERISTIC DAMAGE IN SECTION UNPROTECTED BY GROINS



GROIN 3 RAISED AND OUT OF LINE—CHARACTERISTIC DAMAGE

There is no question in my mind that if the groins had not been started and built as far as they have been constructed, all of the buildings along the entire Long Beach ocean front would have been either seriously damaged or entirely wrecked.

From close observation of my department, myself and disinterested persons, I have come to the conclusion that the greatest proportion of damage was done to groins by foreign floating material, which first wrecked our protection works.

Construction of Martin Dam

In the article describing the construction of Martin dam in Alabama, in *Engineering News-Record*, Dec. 30, 1926, it was stated, on p. 1071, that the Dixie Construction Co. is a subsidiary of the Alabama Power Co., carrying on all the construction operations required by the latter company. It should have said that the Dixie Construction Co. is a subsidiary of the South Eastern Power & Light Co. The South Eastern Power & Light Co. is a holding company, of which the Alabama Power Co. is a part and the activities of the construction company extend to the requirements of any of the constituent companies of the South Eastern Power & Light Company.

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Stone Monolith of 260 Tons Moved 80 Miles by Sea and Highway

THE NORWEGIAN artist Vigeland is engaged on a group of large sculptural works which are going to be erected in a park at Oslo. This group includes a monument of granite, which the sculptor wished to be made of one single piece of rock. The stone has a length of 56 ft., a base 8.75 ft. square, and the top 6.4 ft. square. The weight is 260 tons.

To find rock suitable for the blasting out of a piece of stone of those dimensions was not easy but ultimately such a place was found in the southeastern part of Norway, near the city of Fredrikshald at the famous granite quarries of N. S. Beer.

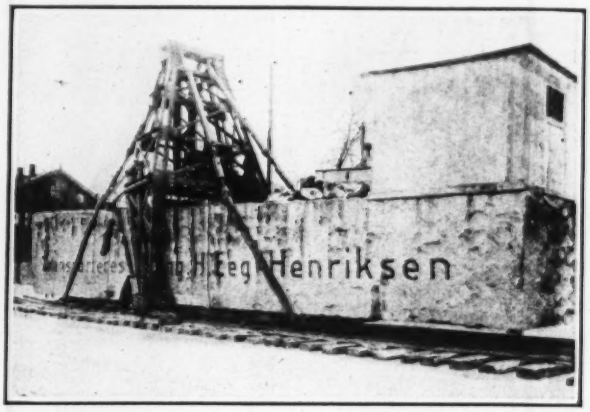
Tenders for the transport of the monolith were received and included 80 miles by sea to Oslo and then 1.5 miles by highway to the place of erection. The contract was let to H. Eeg Henriksen, a well-known engineer, for the sum of 74,000 kroner ($19,000). The highest bid was 286,000 kroner ($75,000). The contractor has already carried out the first part of his work, the monolith being successfully brought ashore near Oslo. The sea transport was accomplished by means of two steel barges each of 200 tons capacity.

The further travel by highway is now going on and

LOADING THE MONOLITH ONTO SEAGOING BARGES

is carried out in a very interesting manner as shown in the illustrations. A steel trestle 23 ft. high is placed approximately at the middle of the stone with one leg on each side. Flat iron suspenders are stretched from the top of the trestle to two fixed points on the lower side of the monolith. The lower ends of the trestle legs are each connected to a piston, placed in a cylinder, which has a pipe connection to an electrically-driven hydraulic pump. The cylinders are suspended by means of pivots in bearings, which transmit the load to the base plate resting on the ground.

To move the monolith the trestle is placed in an inclined position, top foremost, the pump is started and the pistons lift the trestle. The suspenders then tighten and gradually the pressure on the ground decreases, consequently also the friction. At the same time the horizontal power component increases and as soon as



SPECIAL DEVICE FOR HANDLING MONOLITH ON LAND

this becomes larger than the friction the stone moves forward without being lifted from the ground.

Underneath the stone steel beams are provided resting on rollers with steel rails forming the track. To change the direction in curves the rollers are simply placed on an oblique angle. By each lift the stone is moved about 5 ft., and when this step is performed the water is let out of the cylinders. The legs of the trestle are shortened as the cylinders, by means of a special device, are lifted to their initial position and, as the position of the top of the trestle is fixed by means of a strut resting on the stone, the trestle swings automatically into its new position.

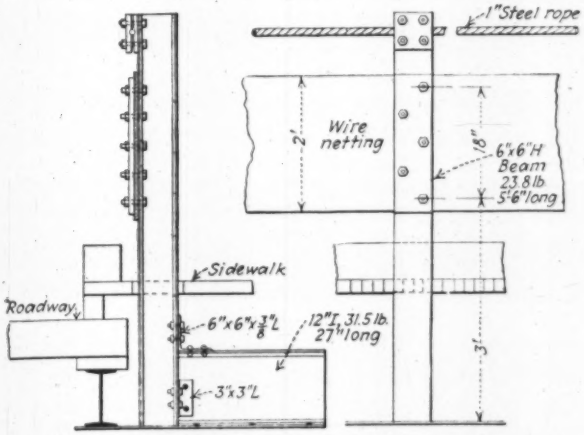
The whole crew needed for the transport is six men. The transport has so far taken place according to schedule and without any accidents.

Transports of a similar kind in latter times include the Luxor Obelisk, which was moved to Paris. It was 73 ft. long and weighed 225 tons and the transfer consumed 7 years. Cleopatra's Needle was moved to London in 1877-78. It was 69 ft. long and weighed 186 tons.

New Curb Guard for Bridge Protection in District of Columbia

SEVERAL recent accidents on bridges in the District of Columbia, in which automobiles went over the curb and through the handrail with fatal results, led to the design of a strong curb guard to prevent the recurrence of this type of accident. D. E. McComb, engineer of bridges of the district, designed this guard shown in the adjoining drawing. It comprises 6x6-in. H-beam standards strongly fastened to the transverse floorbeams of the bridge just outside the curb line, projecting about 4 ft. above the roadway floor; a top line of 1-in. steel rope strung along these posts and clamped to them; and below this a 2-ft. width of wire netting of 2-in. mesh, No. 6 wire. The rope is stretched tight, the mesh sufficiently to take up the slack.

These guards have been applied to the Calvert St.

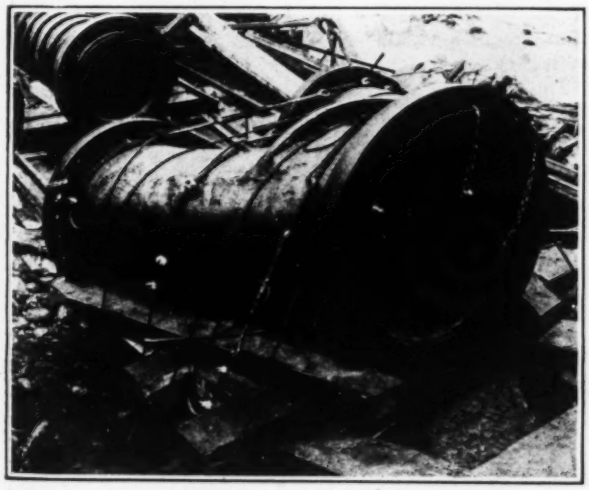


CURB GUARD ADOPTED IN DISTRICT OF COLUMBIA

bridge over Rock Creek gorge and to the Klingle Road bridge some distance northwest of this point. Since their erection they have been struck a number of times and have withstood the impact without failure or injury to the guards.

Turnbuckles Simplify Fastening Heavy Casting to Timber Cradle

IN delivering a heavy, 48x34-in. cast-steel wye for the penstock of the Balch hydro-electric project in California it was desirable to fasten the wye rigidly to a timber crib or cradle on which it could be skidded up a steep incline to its place in the line. The fastening was made of three lengths of ¾-in. steel cable, each doubled so as to pass twice over the top of the casting with the loops passing under the projecting ends of the 10 x 12-in. timbers constituting the crib. The two ends of each



CRADLE CARRYING 48x34-IN. WYE READY FOR INCLINE

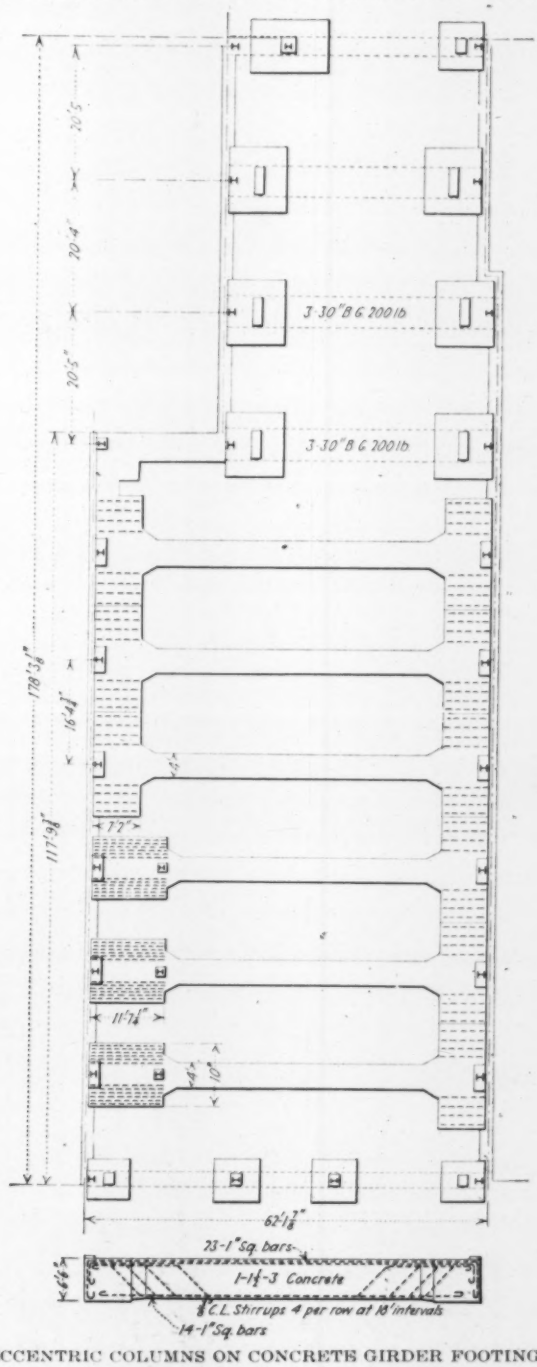
cable were then passed through the eyes of a turnbuckle and clipped, thus making it possible to put the desired tension in the cables simply by tightening up the turnbuckles.

This fastening was easily and quickly effected and held the casting firmly to the cradle while it was skidded up the timber incline.

Reinforced Concrete Girder Footings Carry Eccentric Columns

BY CHARLES CARSWELL
Philadelphia, Pa.

FOUNDATIONS consisting of H-shaped reinforced-concrete girders were used in a garage building in Philadelphia to take care of eccentric column location.



ECCENTRIC COLUMNS ON CONCRETE GIRDER FOOTINGS

The structure is a four-story garage 62 x 178 ft., of steel and concrete construction, at 321 North Fourth St. The floors are 4½-in. concrete slabs on steel beams and

girders, designed for a live-load of 120 lb. per sq.ft. The footings rest on gravel at 7,000 lb. per sq.ft.

The columns are located close to the side property lines, while the footing centers were necessarily located farther in. With the heavy column loads (480,000 to 600,000 lb.), large eccentricity moments at the footings had to be taken care of. This was done by connecting opposite footing blocks by deep reinforced-concrete beams, 6 ft. x 4 ft., across the width of the building, as shown in the adjoining drawing. In the narrower rear part of the building, steel cantilever grillages are used in place of concrete beams.

The garage was built for Michael Egnal, by J. S. Fuller, architect, and A. P. Valentine, Jr., structural engineer.

Two-Man Crew Paints 6,241-Ft. Cable Span in 4½ Hr.

IN ORDER to expedite the work of painting the steel power cables which make a 6,241½-ft. span across "The Narrows," a constricted portion of Puget Sound near Tacoma, Wash., a car was designed in which two men could be suspended from the cable and thereby haul themselves across the span while applying the paint.

The car was suspended from the cable by two sheaves, one at each end of the car framework which also carried a rubber-faced traction sheave near the center in a position where it at all times pressed up against the cable from beneath and was thus obliged to turn as the car moved along the cable. For downhill travel a friction brake operated by a hand lever prevented the sheave from turning too rapidly and for uphill travel a crank was fitted to a gear train with which the rubber-faced sheave was turned by hand power, thus "grinding" the car up the slope.

The paint was applied by specially-built brushes with bristles set in two semicylindrical blocks of wood about 6 in. long. These two half cylinders were designed to be clamped around the cable. The brushes were contained in a sheet-metal box likewise built in two halves and with holes for the cable through either end, the paint being prevented from running out of these holes too freely by use of thick, soft felt washers. In addition to space for the brushes the container had a small reservoir at one end of the brush which was kept filled with paint, being connected by a hose to a 15-gal. paint reservoir mounted at a higher level on the car frame, the flow of paint being controlled by a valve.

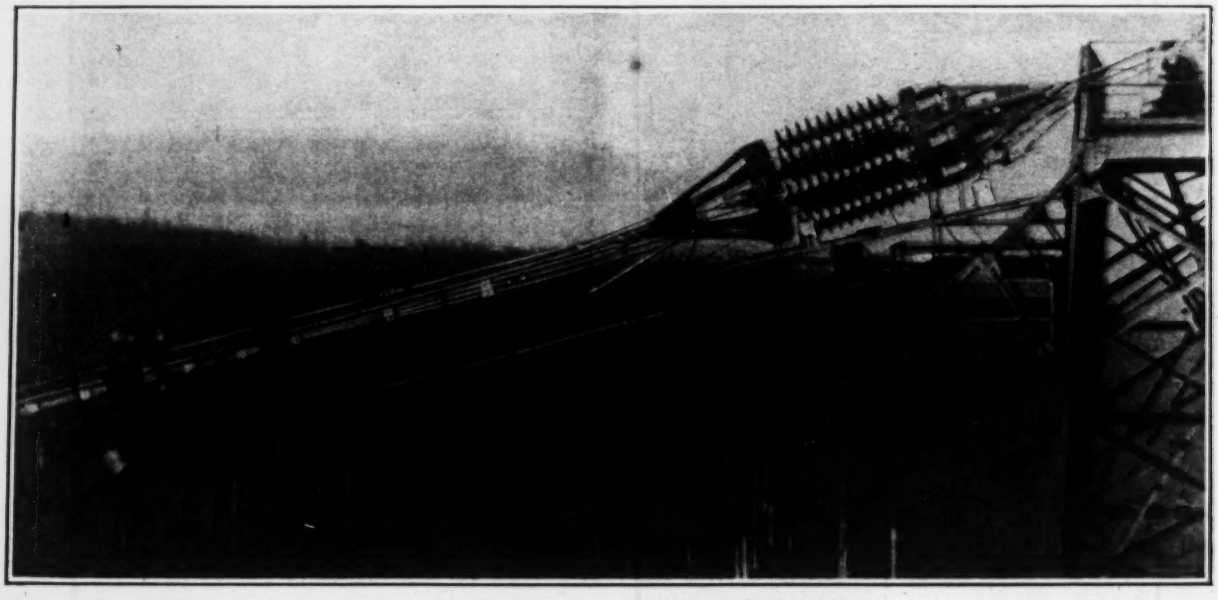
With this equipment a satisfactory painting job was done simply by moving the car along the cable and feeding paint to the cylindrical brush. After a little experience it was found that the most effective application of the paint to the cable was secured by slowly rocking the box containing the brushes from side to side as it moved along. There was no difficulty in pulling the car up the steep slope with the hand winch, in fact, on its first tryout the car was moved by hand power from ground to the top of the steel towers on the anchor cables which rise 317 ft. in a distance of 900 ft.

The car was designed by J. P. Murphy who sub-

From Job and Office

Hints That Cut Cost and Time

CLOSE VIEW OF CAR AT CABLE ANCHORAGE
Paint reservoir, above, supplies brush box on cable at right. Note crank geared to sheave for moving car.



PAINT CAR NEAR THE TOP OF ONE OF THE TOWERS
The 6,241-ft. span between towers was traversed by this car in 4½ hr. Towers are 317 ft. high.

From Job and Office

For Contractor and Engineer

contracted the erection of cables for the Star Iron & Steel Co. of Tacoma, Wash., general contractors for the span, which is part of Tacoma's Lake Cushman power project under direction of J. L. Stannard, chief engineer.

Cleaning Concrete Joints With Air

By W. H. Rhodes

Maintenance Engineer, Oklahoma State Highway Commission

IN making repairs to concrete pavement some time ago we found that we were not having very satisfactory results in cleaning and filling the joints. We were using brooms of various types with which we were sweeping

AIR HOSE CLEANS CONCRETE PAVING CRACK

the cracks as clean as possible. We also used a pick sharpened to a fine point with which to loosen the dirt. This method left dust and dirt in the crack which prevented the new asphalt from filling the bottom and adhering tightly to the sides of the joint. Also it sometimes took three men cleaning joints with brooms to keep ahead of one man with the pouring pot.

In order to correct these faults a small compressor was purchased and mounted on skids. This compressor outfit was then placed in an ordinary Ford truck. To the outlet of the tank was connected a 60-ft. air hose at the end of which we added a thumb nozzle with a point about 30 in long made of a ½-in. gas pipe. The compressor gives us a pressure of about 100 lb. and with this pressure we are able to blow out of the cracks all the dirt and dead asphalt, leaving the crack absolutely clean. This is done without any picking or other loosening. This work takes only a few minutes on each crack and we found that one man with the air compressor kept ahead of two men with pouring pots.

We estimate that this process has saved about fifty per cent of the cost of labor on crack filling. On the joints cleaned this way we have practically none where the asphalt has picked up or peeled.

On the truck we carry boxes of dry sand and chats with which to cover the asphalt after being spread.

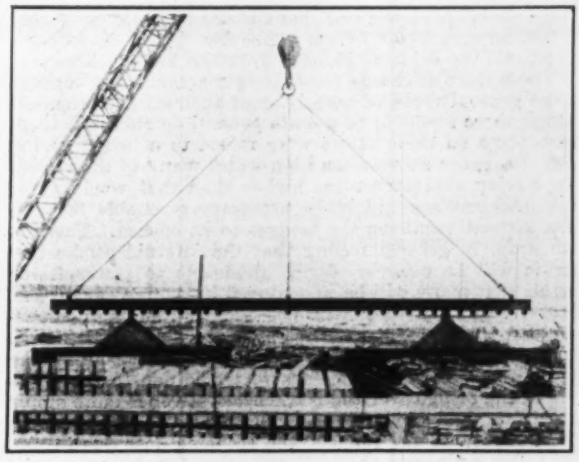
"Strongback" Has Four-Point Suspension for Lifting Concrete Piles

CONCRETE piles built at Los Angeles harbor for municipal waterfront improvements, while being cured and impregnated with asphalt are handled very carefully to avoid danger of small cracks that might make the piles vulnerable to the attack of sea water. One of the requirements in handling is that a 4-point suspension must be used when the piles are lifted horizontally. To meet this requirement a structural steel strongback was built—shown in service in the picture.

The piles now being constructed are 44 to 56 ft. long, 16 in. square, and have chamfered corners. A minimum of 60 days for curing is allowed between the time the piles are cast and the time the asphalt treatment is applied. Piles are moved from the casting yard to the treating cylinders on three or four steel-frame carriages, the number of carriages depending on the length of the pile. The spacing of the carriages is arranged to prevent tension in the pile that might cause cracking and the tracks upon which these carriages operate are kept carefully leveled to avoid uneven support.

The piles are lifted to and from these carriages by a strongback consisting of one main beam 38 ft. long and two smaller beams centrally suspended so that the tension will equalize in the cables they support. The main beam is made of two 10-in. x 24.9-lb. ship channels, 1½ in. back to back with a ½ x 14½-in. plate on top and bottom. The top plate extends the full length of the beam and is riveted to channels at 5-in. intervals.

Hangers ⅜ x 6-in. in size are riveted to the main beam as shown to provide for various spacings to suit



"STRONGBACK" LIFTING CONCRETE PILE

piles of different lengths. From these hangers are suspended the two smaller beams, each consisting of two 8-in. x 11½-lb. channels, ⅜ in. back to back. The strongback is operated by a locomotive crane.

Design of this strongback was worked out by the Los Angeles Harbor Department, division of engineering, G. F. Nicholson, harbor engineer.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Economic Comparison of Tunnel and Bridge

Sir—The letter in your issue of Dec. 9 by C. F. Loweth in which he expresses a desire to "draw out . . . facts" which might indicate the economic value of a tunnel as compared with a bridge in a situation of this kind, has just come to my attention. It occurs to me therefore that a very brief résumé of part of the arguments presented to the War Department in the application by the New Jersey highway department in the matter of the Hackensack and Passaic River crossings of its Route 1 Extension may be of interest. This is as follows, in so far as it refers to the Hackensack River bridge:

"The estimated costs of construction of bridges over, or tunnels under, the Hackensack River, are (from Sta. 228+57 to Sta. 272+28):

Tunnels	$7,156,611
Bridge	4,040,880
Difference	$3,115,731

"The above are preliminary estimates based in the case of the bridge on the vertical-lift type of bridge to provide 35-ft. clear headroom when closed; and for the tunnels on twin tubes sunk into place in a dredged trench.

"In connection with these estimates of costs it is of course necessary to consider the economic factors which affect the traffic and which, in the case of the bridge, are the delays to traffic due to the openings to permit vessels to pass, and in the case of the tunnels, the rise and fall due to the difference in elevation. The matter of delays to bridges is discussed at length in Appendix B following. This appendix gives data of the bridge openings from the records of the bridge tenders and, in Table 8, an estimate of the number of openings which will be required for vessels requiring 35-ft. headroom when the traffic on the Passaic River has reached twice its present volume, and the traffic on the Hackensack River four and one-half times its present volume. On this basis it is estimated that the amounts which might profitably be spent to eliminate these bridge openings on the two rivers would be $13,300,000, and of this amount $8,000,000 is applicable to the Hackensack River, and the balance, $5,300,000, to the Passaic River.

"These calculations do not take into account any changes in the general types of vessels or of their construction, although there seems to be a quite general opinion that if all the bridges on these rivers were raised to a height giving 35-ft. clearance above mean high water many of the vessels now having superstructures higher than that would make such alterations as might be necessary to enable them to pass without requiring the bridges to be opened. There is also a fairly general feeling that the internal combustion engine will be made so easily applicable to power-driven vessels that many will be so equipped in the not far distant future, and that they will not require the high superstructures which are now necessary for steam. It is felt, therefore, that the above estimate of $8,000,000 as the capitalized value of the delays to traffic due to the openings of the bridge over the Hackensack River is quite ample and a fair figure to use.

"In regard to the tunnels, the economic loss due to rise and fall is estimated at $9,680,000. See Appendix C: Estimated Economic Values of Rise and Fall; Additional Costs of Operation on Ascending Gradients.

"The comparative economic values of tunnels under and bridges over the Hackensack River are therefore:

Bridge	
Estimated cost of construction	$4,040,880
Capitalized cost of delays	$8,000,000
Total	$12,040,880
Tunnels	
Estimated cost of construction	$7,156,611
Capitalized value of rise and fall	$9,680,000
Total	$16,836,611

and there is, therefore, an economic saving of $4,795,731 in favor of the bridge." F. LAVIS,

New Jersey State Highway Commission.

Jersey City, N. J.
Feb. 23, 1927.

Short Courses for Plumbers

Sir—The editorial comment, "Plumbers Next," which appeared in your issue of Feb. 10, 1927, p. 224, sounds a very encouraging note in the progress of the development of knowledge of sanitary science. Your statement that "plumbers have been overlooked heretofore" is not, however, entirely in accord with the facts.

The idea of a "short course" which you mention came into prominence here during the annual convention of the Illinois Master Plumbers Association in 1922, following an address in which the plumbing tests being conducted at the University of Illinois were described. The Illinois Master Plumbers Association then voted to participate financially in the conduct of the test and it formally requested the state university to conduct a two- or three-day short course.

Our first short course was given Jan. 29 to Feb. 3, 1923. The editor of *Domestic Engineering*, who should be acquainted with what is going on in plumbing, was pleased to publish an extensive article entitled, "The World's First Plumbing Short Course" in which the details of this course were described. The attendance at the course was so large and enthusiastic that the course was repeated on Jan. 31 to Feb. 2, 1924. The course was enlarged to a five-day period and repeated Sept. 15 to 20, 1924. It was given a fourth time for five days on a date I have not now in mind.

I have before me a program of a three-days course held at Carnegie Institute of Technology Nov. 12 to 14, 1924. A short course was held at Purdue in February or March, 1926, and other short courses or conferences have been held at other institutions of higher learning during the past few years.

It is hard to say that there is anything new under the sun, but much credit must be given to the Illinois Master Plumbers Association, and particularly to C. D. Brownell, the chairman of its Educational and Research Committee, for his efforts in starting and maintaining interest in scientific education for the master plumber.

H. E. BABBITT,
Professor of Sanitary Engineering.

University of Illinois, Urbana,
Feb. 12, 1927.

Sir—In you issue of Feb. 10 the following statement appears in the editorial entitled "Plumbers Next": "So far as we know, plumbers have been overlooked heretofore, although presumably they have been included in "extension work.—"

We are taking the liberty, therefore, to send you copies of programs for three annual Institutes for Master Plumbers and Heating and Ventilating Engineers, held for the last there years at the Carnegie Institute of Technology. These Institutes have been held under the direction of the Department of Industrial Relations of the Department of Heating, Ventilating, and Sanitation of the Carnegie Institute of Technology. The attendance at each of the Institutes has ranged between 250 and 300—master plumbers representing Pennsylvania, Ohio, New York, and other nearby states. As far as we know the plan to conduct these three-day meetings originated with the Carnegie Institute of Technology. R. S. CLARK,

Pittsburgh, Pa., Feb. 14, 1927. Manager News Bureau, Carnegie Institute of Technology.

[We took care to preface the words quoted by our remarks with: "It is not safe to say that a fresh announcement is the first in any given field." We are pleased to record the earlier short courses for plumbers noted in the foregoing letters. Illinois has a lead of a year over Carnegie.—EDITOR.]

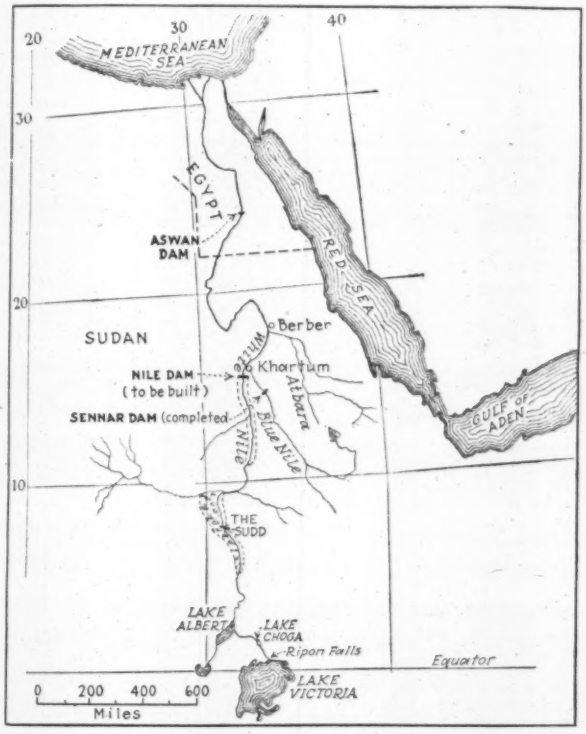
A Plan for Full Development of the Nile River

Sir—It is reported that a costly storage reservoir is to be built on the White Nile for irrigation purposes. This gives occasion for directing attention to an alternate plan of development of the Nile which possesses marked advantages over the one that is apparently being carried out. The proposed plan, though known to a small circle of engineers, has not hitherto been published.

Under the plan now in execution, the reservoir, which is to be built at the lower end of the White Nile, will subtract a certain quantity of water from the peaks of the Blue Nile floods which pass the recently completed Sennar dam and back up along the course of the White Nile. But it cannot measurably ameliorate flood conditions below. The floods of the Lower Nile never originate on the White Nile, as this tributary has a relatively small, constant flow.

The new reservoir will furnish summer water to 900,000 acres of land, at a cost of over $20,000,000, or say $25 per acre. It will lose by evaporation from its surface a somewhat larger quantity of water than it makes available. The water will be supplied only after a five or six-year construction period, and then will not be sufficient to cover the growth of demand in the interim.

The essential feature of the proposed alternate plan is



SKETCH MAP OF NILE VALLEY

to lower the outlet of Lake Victoria (at Ripon Falls) and draw the lake down through a long period of years to an elevation about 45 ft. lower than the present. The water thus drawn from storage will be about 674,000,000 acre-ft. and would furnish summer water for 6,000,000 acres for 50 years.

Making certain not unreasonable assumptions as to colonization rates, water requirements, etc., it may be shown that this drawing-down process may be spread over a period of 107 years. At the end of that time the lake will have been reduced in area from 66,000 to about 55,000 sq.km., and an annual saving effected of 10,500,000 acre-ft. of water now lost by evaporation.

Additional features of the plan (which features, however, may be deferred many years) are:

(1) Lower by about 18 ft. the channel below Lake Choga so as to eliminate that lake and save 2,000,000 acre-ft. of water annually.

(2) For accurate regulation, build at some future time regulating works at the outlet of Lake Albert as well as at Lake Victoria. These works should control about 18 ft. in elevation of water.

(3) Dredge a channel around the east side of the Sudd, eliminating that swamp, saving most if not all of the 14,000,000 acre-ft. annually lost, and probably converting much of the present swamp into irrigable land.

Complete regulation of the White Nile, with the above described savings from evaporation, will permit the irrigation of 16,000,000 acres in addition to the present 7,000,000 plus or minus; this would be 6,000,000 acres more than is possible under any alternate plan. Development of this area would permit the useful application of the entire Blue Nile flood, in other words would completely develop the entire Nile. It would also permit a better cultivation of millions of acres now covered by water for two or three months of the year.

The total estimated cost of all the works above described (to develop 16,000,000 acres) is $190,000,000. This does not include the distribution systems, which would be the same in any case, and which may be tentatively estimated, for purposes of comparison, at $40 per acre. While gigantic in magnitude, the plan is susceptible of division into a series of installments which would keep ahead of any possible rate of demand, while still holding the acre costs down to a very low figure. Thus, building first the regulating works and some channel improvement at Lakes Victoria and Albert might cost $21,000,000, but it could be done in one-half the time required for the White Nile dam and would supply 3,000,000 acres. Some of the more expensive items of work could be deferred for 50 or more years.

The value of this plan over any alternate lies in lower first cost, saving of interest on deferred expenditures, and the value of 6,000,000 additional irrigated acres. Its total may conservatively be set at $660,000,000.

The late Prof. N. S. Shaler estimated that the Nile valley contains irrigable land to the extent of 7 to 11 times the then irrigated area (in 1905 about 6,000,000 acres). Egyptian cultivators at present pay in rents, taxes, water rates, etc., the equivalent of 8½ per cent on a valuation of $250 per acre. Note the difference between a country where the people are waiting for the land and a country (as the United States) where the land waits for the people. Additional cultivable area has not been provided for years, and the growth of population in Egypt is such that 45,000 to 50,000 potential cultivators per year cannot obtain land, to say nothing of future development in the Sudan.

Mere announcement of this plan should allay any Egyptian fears that they were being robbed of water in favor of the Sudan, in fact it would eliminate any question of division of water between the two countries. Relief wou'd be afforded in half the time, to three times the area, and at much less cost.

CHESTER W. SMITH.
Consulting Engineer.

Newburyport, Mass.,
March 1, 1927.

The Status of Registration in Virginia

Sir—In your issue of Feb. 10 there appeared on p. 250 a letter signed by fifteen engineers of St. Louis in reference to the present status of registration of engineers. In this letter it is stated that in Virginia the advocates of registration have gone so far as to make an agreement with the membership committees of the national societies that no man will be approved for membership in a national society unless he has registered under the state law.

I do not know where this rumor started. As a matter of fact I have been chairman of the membership committee in Virginia for the civil engineers for two years and am also a member of the mechanical society. I have certainly not made any such agreement nor has anyone ever proposed such an agreement to me. As you can imagine, there are some enthusiastic engineers who believe that the registration law will solve all the difficulties, who may possibly have made up their minds not to endorse anyone unless he has registered. So far as the general body of engineers in Virginia are concerned, however, from my contact with them I would say that the registration law has not

affected them one way or the other. Although personally I do not believe that registration will accomplish even a part of the objects that its advocates hope for, still I feel that it doesn't hurt to try it out except that it cost us each $5 a year.

I write this letter simply because the letter in your issue of Feb. 10 would leave anyone under the impression that in Virginia all the engineers were rampant in favor of registration. Such is not the case. There is little or no interest in the question among a large group of engineers.

I hope you will publish this letter because the letter which you published on the 10th implies a narrow-mindedness on the part of the engineers in Virginia that is very unfair and in no sense true. ALLEN J. SAVILLE.

Richmond, Va.
Feb. 18, 1927.

Concrete Piles Unaffected by Sea Water

Sir—In view of the articles which of late have been written concerning the unsuccessful use of reinforced concrete, especially in sea water, it may be of interest to know of the *successful* use in sea water of certain reinforced-concrete piles.

The piles successfully used were built by the U. S. Engineer Department for the support of hinges and gallows frames of two ferry aprons in Humboldt Bay, Calif., at north and south spits, used for landing stone loaded on railroad cars. The pertinent data concerning these piles are tabulated below:

Number of piles: 48.
Length of piles: 30 to 50 ft., penetration about 20 ft., largely in sand.
Cross-section of piles: square with beveled edges, section 16x16 in. to 12x12 in., 10 ft. from bottom.
Minimum distance of reinforcement from surface: 1 in.
Kind of reinforcement: ¾-in. square corrugated bars for 30-ft. piles and 1-in. for the 40 and 50-ft. piles.
Depth of water: 6 to 27 ft.
Time in use: 10 to 15 years.
Mix of concrete: 1:2:3, by volume.
Time of mixing concrete: 3 minutes (by machine).
Cement: Northern California portland cement (U. S. Standard Specifications).
Aggregate: Hornblende schist stone, 1 in. maximum diameter.
Sand: From selected spots on beach.
Water: Fresh, sometimes a little brackish. A soft mix was used with sufficient water only to allow proper filling of concrete in form around reinforcing steel.
Forms: S 1 S, 2-in. pine planks, *made watertight.*
Curing: At least 30 days in the open. The open tops of the forms were kept well covered with moist sand.
Surface of piles: Plain—no coating.
How Driven: By piledriver hammer and water jet. A 1-in. pipe penetrated the piles for jetting purposes. Some hammering was required for each pile.

The piles have been subjected to heavy, varying loads and strains and some piles are a little worn by abrasion. No evidence of the least disintegration, swelling or cracks is indicated on the surface of the piles, although small pieces of the corners have been knocked off in many cases during handling or driving or during service. In other words, the piles after many years' use in sea water are apparently as good as ever. Half of these piles were built and placed in 1911, and the others in 1915. After four years of service, two piles which were, in 1915, broken by a severe blow of a vessel, were removed and examined thoroughly and found to be well made and sound throughout. The principal precautions taken in the work are given below in what is considered by the writer to be the order of their relative importance:

(a) Enough water to make a mixture sufficiently fluid to insure a solidly deposited concrete throughout the form.
(b) Ample time of mixing concrete to make a thoroughly homogeneous concrete.
(c) Watertight forms so that no cement content is lost from the concrete.
(d) Slow and ample curing in the open.
(e) Clean reinforced steel.

It is a question as to whether above item b or c is the more important.

The climate of Humboldt Bay, Calif., is remarkably mild, cool and equable, the extreme temperatures being from 20 to 85 deg. The mean temperature for January is about 47 deg. and for August about 56 deg. The diurnal range of temperature is about 11 deg. and the atmosphere is largely moist, cloudy or overcast. The sea water in the bay ranges from about 55 to 60 deg. in temperature throughout the year. There is seldom snow or ice.

San Francisco, Calif., GEORGE F. WHITTEMORE,
Jan. 28, 1927. U. S. Engineer Department.

Submerged Contact Aerators

Sir—Under the caption "Submerged Contact Aerators Not New" you published a letter from Langdon Pearse in your issue of Dec. 30. This it seems to me places both Dr. Imhoff and the writer in a somewhat unfair light. Dr. Imhoff in his article, which is the subject of Mr. Pearse's discussion, mentions several earlier devices, one of them dating 1891.

But the device described by Dr. Imhoff has one distinctly novel feature not so far as we are aware included in any of the other earlier devices. We refer to the arrangement of the air blast so that the contact material is continually kept swept free of the accumulations of biological growth and organic matter. In the earlier types of contactors or colloiders there was no means of preventing the accumulation of organic matter which occurred to such an extent that it became septic. As soon as septic action sets in the organic matter becomes redispersed in the liquor and the purification previously affected is undone. This one novel feature appears to be the determining factor between success and failure. In the experiments at Urbana to which Dr. Imhoff refers the removal of biological growth was accomplished at will by mechanically agitating or shaking the contact surfaces from time to time.

The installation at Kettwig is more completely described in Dr. Imhoff's book [in German] on the "Progress of Sewage Purification." From this description it appears that the contact aerator was installed in one of four Imhoff tanks treating the sewage from the city of Kettwig, the population of which is given as 6,000. This tank was therefore treating the sewage from 1,500 population. The effluent was compared with that of the other three tanks in which no contact aerators were installed.

Urbana, Ill., A. M. BUSWELL,
Feb. 14, 1927. Chief, State Water Survey.

Welded Building Construction

Sir—I have read with interest your article on the arc-welded Sharon Building given in your paper of 20th January. It is, however, not by any means the first building designed expressly for arc welding and constructed therewith. I designed and took direct charge of the manufacture and erection of such a building some eight years ago in Glasgow. It is the most rigid building known there, comparatively speaking.

FLOOR PLATE STIFFENED BY WELDED TEE

Your details are going on the right lines under present conditions, but such details were demonstrated by me in a lecture to the Civil Engineering Society of the Royal Technical College, Glasgow, in 1919, and have been embodied in construction since then.

By the way, the only hole in any bar or member of the structure to which I refer was to pass the bolt of the door lock.

Constructional friends in America might find it useful also when using steel floor plates to stiffen them as per detail in the drawing shown herewith.

Middlesborough, England, H. A. MCCREADIE.
Feb. 11, 1927.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Civil Engineers Change Method of Nominating President

At the regular monthly meeting of the American Society of Civil Engineers, held at the society's headquarters in New York, March 2, the result of the balloting on the proposed constitutional amendment providing for a change in the method of nominating candidates for the presidency, was announced. Of the total of 2,826 votes counted, 2,627 voted "yes" and 199 voted "no." The amendment was declared to be adopted. In general, it provides that nominees for directors and vice-president shall be selected by the same method as that now in effect and that the nominee for president shall be selected by a nominating committee consisting of the 18 directors and two latest living past-presidents. Provision is made that no member of the nominating committee shall be eligible for election to the office of president until at least two years after the expiration of his term of office. The time required for effectuating all of the nominations has been shortened as much as possible. This amendment to Article VII of the constitution was published on p. 490 of the December, 1926, *Proceedings* of the Society.

A paper on the subject of the construction methods on the Moffat tunnel through the Colorado Rockies, by R. H. Keays, published in the February, 1927, *Proceedings*, was presented at the meeting by J. Vipond Davies in the absence of Mr. Keays, who is in Greece.

Present Chippawa Intake Found Not to Infringe Groat Patent

Justice Masten, at the Non-Jury Assizes in Toronto, Ontario, Can., has rendered a decision in favor of the Hydro-Electric Power Commission of Ontario, in the suit of Benjamin F. Groat vs. the Hydro-Electric Commission for infringement of a Canadian patent in the construction of the intake of the Queenston-Chippawa plant of the commission at Niagara Falls. The patent granted to Mr. Groat in both Canada and the United States is upon the design of an intake to keep ice and other floating materials from being carried in to the intake channel by surface currents. Essentially it consists of channels excavated on the river bottom outwardly from the head-race and in a general transverse direction to the main currents of the river from which the water is being drawn. By these channels water is drawn from the lower portion of the stream without altering the direction or the "transportivity" of the surface currents. The device was described in the *Transactions* of the American Society of Civil Engineers, Vol. LXXXII, p. 1138 (1918.)

The intake for the Queenston-Chippawa plant of the Ontario Hydro-Electric Commission originally was designed to be of the Johnson-Wahlman type, a type described in *Engineering News-Record*, Dec. 16, 1926, page 998. Briefly, it consists of a curtain wall across the mouth of the Welland River (the direction of flow of which has been reversed) through which are 15 openings, 6 or 7 ft. below the surface. In front of the wall and extending out into the river a distance of about 100 ft. is a pool of depths decreasing outward into the river. The design called for the construction of 6 "gathering tubes" extending from the curtain wall out across the bottom of the river a distance of 675 ft., the tubes having a narrow opening on the upper side and a diameter increasing from a small opening at the outer end to a large opening, approximately 18 ft. wide and 28 ft. high at the curtain wall. However, only the sockets in the face of the curtain wall which were to receive these tubes and the foundation blocks for the support of the tubes near the curtain wall were built when the river was unwatered for the construction of the curtain wall. At the present time water is drawn from the deep pool through the sub-surface openings in the wall, and through the sockets which extend out into the channel 25 ft. and are 14 ft. below the surface.

The decision of Justice Masten was based upon the present condition and not upon the completed intake as originally designed. As to the infringement he said, in part: "Nor, in my opinion do these sockets 14 ft. below the surface have any appreciable effect on the speed of the surface current. In short, whether or not sockets and channels create a scintilla of effect, they have not practical bearing on the operation of the defendant's plant and the defendant has not, by constructing them adopted or infringed the plaintiff's invention. Before leaving the case I repeat that I express no opinion on the validity of the plaintiff's patent nor as to whether the installation by defendant of the tubes as originally suggested would be an infringement."

Engineering Fifty Years Ago

From *Engineering News*, March 10, 1877

WORK for the season has been commenced on the new court house. It will require $450,000 to enable contractors to finish the work satisfactorily, a sum which in the present financial condition of Chicago and Cook County will not very likely be forthcoming.

Hudson River Bridge at Catskill Proposed by State

Reporting on surveys for a bridge across the Hudson River at some point between Albany and Poughkeepsie, Col. F. S. Greene, superintendent of public works, has just recommended that the bridge be located at Catskill, about 35 mi. south of Albany. He estimates its cost at $6,000,000. Three alternative plans for the structure are offered. One contemplates a suspension bridge with 1,050-ft. main span and two 525-ft. side spans, the second three arch spans of about 650 ft., and a third a 600- and two 400-ft. spans, with suitable trestle approaches in all cases. The total length of bridge with approaches is about 1 mile, and the vertical clearance provided will be 150 ft. above high water.

Traffic studies indicated that such a bridge is needed, according to the engineers. The most economical location, they found, was at the southerly end of Rogers Island, just north of the village of Catskill. However, until borings are made to explore the foundation soil, a definite cost estimate cannot be made. At the Catskill site the bridge would link the region east of the Hudson with the Catskill-Windham route and the Rip Van Winkle highway through the Catskill Mountains.

The survey was made under direction of Arthur W. Brandt, highway commissioner, by J. S. Bixby and Perry Filkin, division engineers. and H. O. Schermerhorn, bridge engineer of the department. Operation under toll is suggested, to refund the cost of construction.

Stress Distribution Tests to Be Made on Concrete Bridge

Stress distribution tests are to be made on a reinforced-concrete highway bridge over the Yadkin River between Albemarle and Mt. Gilead, North Carolina. The bridge is composed of three open-spandrel arch spans of about 150 ft. each and 14 T-beam or deck-girder spans of about 40 ft. each. Tests are to be made, ultimately, to the complete destruction of the structure. It was built in 1922. The tests are made possible because a dam is to be built below the bridge, rendering it useless.

Tests will be conducted under the joint auspices of the North Carolina Highway Commission and the Bureau of Public Roads, which organizations will finance the cost of investigations.

It is proposed to organize an advisory committee, made up of representatives of interested organizations, to direct the technical investigation. Selection of organizations which will be asked to appoint representatives to this advisory committee is in the hands of the state highway department and the Bureau of Public Roads.

Am. Soc. C.E. to Sponsor Freeman Hydraulic Scholarship

The American Society of Civil Engineers is about to sponsor a traveling scholarship suggested in 1924 by John R. Freeman, a past-president. The scholarship has been established by Mr. Freeman to afford special study in the theory and practice of hydraulics as exemplified in the hydraulic laboratories of Europe more especially those of Germany.

For the present, candidates for this scholarship will be limited to junior professors, instructors or assistants in American technical schools of recognized standing in which the study of hydraulics forms an important part of the curriculum. A complete statement of the conditions under which the scholarship will be awarded and full requirements may be obtained from the secretary of the Am. Soc. C.E., 29 West 39th St., New York City.

Zoning Constitutional Amendment Goes to New Jersey Voters

A joint resolution submitting to a general referendum vote a constitutional amendment authorizing the New Jersey Legislature to authorize zoning in municipalities other than counties has been adopted unanimously by both branches of the legislature. The resolution reads: "The legislature may enact general laws under which municipalities, other than counties, may adopt zoning ordinances limiting and restricting to specified districts, and regulating therein, buildings and structures, according to their construction, and the nature and extent of their use, and the exercise of such authority shall be deemed to be within the police power of the state. Such laws shall be subject to repeal or alteration by the legislature."

Nine-State Ohio River Pollution Control Pact Signed

With the addition of Indiana, the health departments of nine states have signed an agreement to follow uniform administrative methods in handling interstate pollution problems in the Ohio River drainage area. The other states, says *Ohio Health News*, Feb. 1, 1927, are Ohio, Illinois, Kentucky, Tennessee, West Virginia, Maryland, Pennsylvania and New York.

Survey Equipment to Hudson Bay by Airplane

To speed up survey and investigation work in connection with the construction of the Hudson Bay Ry., the Canadian government has signed a contract with the Western Canada Airways Co. to fly freight and passengers from Kettle Rapids, where the rails now end, to Hudson Bay. It is understood that some four tons of surveying and other equipment will be needed in order that Frederick Palmer, the British engineer selected by the government, can commence his investigations as early as possible.

Valuation Case to Be Reopened

The Kansas City Southern Railroad Co. has been ordered by the Attorney General to test the question of the valuation placed upon it by the Interstate Commerce Commission before the United States Supreme Court. In last December the railroad company obtained an injunction from the federal district court to prevent the Interstate Commerce Commission from fixing a final value upon its property.

The recent decision of the Supreme Court in a similar case of the Los Angeles & Salt Lake Railroad Co., as reported in *Engineering News-Record* of March 3, p. 375, was in support of the commission's action.

Montreal Water & Power Co. Plant Bought by City

The city council of Montreal, Que., recently voted unanimously to accept an offer from the Montreal Water & Power Co., dated Feb. 12, to sell its entire water-works system to the city for $14,000,000. The property includes a pumping station and filtration plant, reservoirs and a large mileage of distributing mains. The company, first known as the Montreal Island & Power Co., began operations about 1889. It acquired the plants owned by several towns adjacent to Montreal and made contracts to supply other towns. Some of the towns have since been annexed to Montreal, but Outremont and Westmount are still outside the city limits. The city assumes a $5,500,000 debt of the company, due in 1932, and may pay the balance in cash or bonds, at the option of the city. It is stated that the city will supply the customers of the company at the present rates charged by the city, which are figured at "6 per cent on the rentals as inscribed in the assessment rolls, in conformity with the conditions of the by-laws on taxes." Under this plan the rates charged by the company will be reduced.

Houston Activated-Sludge Plant to Be Enlarged

To increase the capacity (10 m.g.d.) of the larger of the activated-sludge plants that have been in use at Houston, Tex., for ten years past, the old hopper-bottomed settling tanks will be converted into aërating tanks and new settling tanks with Dorr apparatus for sludge concentration and removal will be installed. After having tried "practically all types of processes and the equipment for sludge dewatering," according to a letter to *Engineering News-Record* from G. L. Fugate, principal assistant engineer, city of Houston, Tex., a decision has been reached to install a vacuum filter for use with the present drying equipment. Mr. Fugate adds: "Preliminary figures indicate that our operating cost for such a plant will not be greater than the sales price of the dry material. The demand for the sludge has steadily increased and there will be no trouble in closing a contract for the annual output of the plant."

New York Engineers Consider License Law Enforcement

The New York State Society of Professional Engineers and Land Surveyors, organized in 1926, held a general meeting at New York on March 8 to which all licensed engineers in the state were invited in order that they might become acquainted with the aims of the organization. The society was organized to devise ways and means of enforcing the engineer license law in the state, to improve the efficiency of public offices of an engineering nature by the employment of licensed engineers, and to insure to members of the profession remuneration commensurate with the responsibility involved.

Among those who addressed the meeting Dr. Downing, deputy commissioner of education of the state, told of the progress made in enforcing the license law during the six years that it has been on the statute books and warned against too hasty action in "putting teeth in the law." Col. Kelly of the New Jersey board described the results being obtained in that state. Dr. J. G. Smith and Julius H. Cohen, counsel for the Port of New York Authority, told of the experience of the doctors and lawyers in the regulation of their profession. Both stressed the point that the first consideration of such an organization as the engineers were building up should not be increased remuneration but the raising of the standards and improving the training of its members.

Maryland Plans Eastern Shore Boulevard 28 Miles Long

The Maryland State Roads Commission plans the construction of an Eastern Shore boulevard connecting Baltimore with the important cities and towns east of the Chesapeake Bay. The highway will be 28 miles long, running eastward from a ferry terminus at Love Point, across the bay from Baltimore. The eastern end will be at Queen Anne, connecting with an existing highway reaching to Denton, near the Delaware border. The actual construction involved is 18 miles, at an estimated expense of $600,000. A bridge over Prospect Bay is included in the project. The road will connect Baltimore with all the main highways of the Eastern Shore and Delaware.

City Manager Charters Upheld in Lower Courts

The legality of city manager charters recently adopted at Rochester, N. Y., and Oklahoma City, Okla., has been upheld by lower courts in each state, except that portions of the Rochester charter providing for a nonpartisan ballot and prohibiting the appointment to an administrative office of any person who had held an elective office within a year. The second of these provisions was designed to prevent the appointment of a member of the city council as city manager. Appeals to higher courts are expected in both states.

To Permit Control of Bathing in New Jersey Water Supplies

Two bills designed primarily to annul the action to control bathing in the public water supplies of New Jersey, taken recently by the State Board of Health in the form of an amendment to the state sanitary code, are now before the legislature. In effect, short of riparian ownership, each bill would remove all control over bathing in public water supplies, while one would remove control over boating and fishing also.

Senate Bill No. 162 reads: "(1) It shall be lawful to bathe or swim in any of the fresh waters of this state; provided, that in so doing no trespass be committed. (2) This act shall take effect immediately."

Assembly Bill No. 91 reads: "(1) Nothing in any law of this state shall be construed to limit, restrict or prohibit the use of any fresh-water lake, pond, brook, creek, stream or river above the point where the tide ebbs and flows, by any riparian owner of land bordering on the same, for the purpose of boating, fishing or bathing therein, or any other lawful purpose so long as the use thereof shall be natural and reasonable, and no court, board, body or other authority of this state shall restrain, prevent, or in anywise interfere with such natural and reasonable use; provided, however, that nothing herein contained shall be construed to prevent the condemnation of property of such riparian owner in the manner prescribed by the statutes of this state, for the use of the same as a public water supply. (2) All acts or parts of acts inconsistent with this act are hereby repealed." An accompanying "statement" runs thus: "The purpose of this act is to prevent the owners of land being deprived of the use thereof for the benefit of either public or private water companies, without compensation being made for the same under the guise that such action is necessary to protect the public health."

New York-Vermont Bridge Compact to Be Drafted

A bill passed by the New York State Legislature and approved by the governor last week creates a temporary commission to formulate a treaty in conjunction with Vermont to provide for the construction of a bridge across Lake Champlain, in accordance with the report of the commission which recently investigated the several bridge sites and chose the Fort Frederick-Chimney Rock site. Gov. Smith has appointed Gen. M. Y. Ferris of Ticonderoga, H. E. Owens and R. E. Lockwood members of this commission, Gen. Ferris to be chairman.

U. of Wis. Gets Engineers' Portraits

In recognition of what has been done to advance the interests of the University of Wisconsin by Prof. Frederick E. Turneaure and the late Prof. Storm Bull, their painted portraits have been presented to the college of engineering by the alumni and faculty, and are now hung in the engineering library.

A. W. W. A. Nominates Officers

The nominating committee of the American Water Works Association has announced the following nominees for 1927-28: President, James E. Gibson, manager and engineer, Water Department, Charleston, S. C.; vice-president, William W. Brush, chief engineer, Department of Water Supply, New York City; treasurer, George C. Gensheimer, secretary, Commissioners of Water Works, Erie, Pa.; district trustees: No. 4 Seth M. Van Loan, deputy chief, Bureau of Water, Philadelphia, Pa.; No. 8, Louis R. Howson, Alvord, Burdick & Howson, Chicago, Ill.; No. 9, George W. Pracy, superintendent, Spring Valley Water Co., San Francisco, Calif. If no other nominations are filed the nominees will be declared elected at the annual convention of the association at Chicago, June 6-11.

Engineering Foundation Elects Officers for 1927

Lewis Buckley Stillwell was re-elected chairman of the Engineering Foundation for the third time at its annual meeting held in New York City, on Feb. 17. Mr. Stillwell, a New York engineer residing in Lakewood, N. J., is past-president of the American Institute of Electrical Engineers and the American Institute of Consulting Engineers. He is a native of Pennsylvania, a graduate of Lehigh, and a life trustee of Princeton. Wesleyan University bestowed upon him the degree of doctor of science.

He is a member of the American Society of Civil Engineers, the Institution of Electrical Engineers of Great Britain, the American Engineering Council, the National Academy of Sciences, the Royal Society of Arts in Great Britain, the American Philosophical Society, and the Franklin Institute.

Arthur D. Little, founder and president of the Arthur D. Little Laboratories of Cambridge, Mass., and inventor of many chemical processes, was elected a vice-chairman. George A. Orrok, a member of the American Society of Mechanical Engineers, the American Institute of Mining and Metallurgical Engineers, and the American Society of Civil Engineers, was re-elected a vice-chairman.

J. Vipond Davies, representing the American Institute of Electrical Engineers and the American Society of Civil Engineers, and Dean Arthur M. Greene, Jr., of the Princeton School of Engineering were named again as members of the Executive Committee of the Foundation.

Other officers elected were: director and secretary, Alfred D. Flinn; treasurer, Jacob S. Langthorn; assistant treasurer, Harry A. Lardner.

New members of the Foundation Board, to represent the United Engineering Society, are William H. Burr, consulting engineer, formerly professor of civil engineering at Columbia University; George L. Knight of the Brooklyn Edison Co., and Alva C. Dinkey, former president of the Carnegie Steel Co.

Earth Dam Near Hemet, Calif., Destroyed by Flood

An earth dam near Hemet, Calif., was carried out by flood waters on Feb. 16, when heavy rainfall caused a runoff in the watershed above exceeding any previously recorded. The structure was the property of the Lake Hemet Water Co., which stores water primarily for irrigation. The heavy runoff was caused by warm rains on snow and there were destructive floods in all the streams of this drainage basin prior to the time the dam gave way. About 7,000 acre-ft. of water from the reservoir was added to the flood which drowned one man, destroyed two small ranches, swept away much of the water company's distribution system and caused extensive damage to roads.

The main dam in the storage system operated by the Lake Hemet Water Co. is a masonry structure 135 ft. high, built to a height of 122½ ft. in 1895. This structure was undamaged by the flood although it was over-topped to a depth of 5 ft. or more. The earth dam that failed was an auxiliary structure, three-eighths of a mile distant, built in a depression in the reservoir rim in 1923 when the masonry dam was raised to its present height.

The earth dam had a total height of approximately 20 ft., a crest length of 273 ft., and a crest width of 10 ft. The upstream slope was 2 to 1, except for 5 ft. at the crest which was on a 1½ to 1 slope. The downstream slope was uniformly 1½ to 1. The puddled core was 8 ft. thick and was to have been made of clay although there is some question as to the quality of the material used in the core. The crest of this dam was carried only 5 ft. above the puddled core which in turn was not carried above the crest elevation of the masonry dam. Thus with a 5-ft. flood over the masonry dam the core of the earth dam was 5 ft. below the surface of the water which stood level with the earth-dam crest.

When the breach occurred the escaping water cleaned off what is reported to be good quality rock foundation, about 22 ft. below the level of the earth-dam crest. Plans indicate that the core trench was not carried entirely down to the level where the rock foundation is exposed. The dam was designed by W. S. Post and was approved by the California Railroad Commission in 1923.

Both Bridge and Tunnel at Detroit Planned

The bill granting the Detroit and Windsor Subway Co. permission to construct a tunnel under the Detroit River has passed the committee stage in the Canadian House of Commons, having been recommended by the Railways and Canals Committee.

The same committee has also recommended that the Canadian Transit Company's charter to construct a bridge between Windsor and Detroit be extended for another five years on the assurance that the company was ready to start construction of the bridge almost immediately.

Kansas City Gets Free Use of Missouri River Bridge

A free highway and street route across the Missouri River at Kansas City, Mo., is practically assured through negotiations by which the city will purchase an easement for highway traffic over the upper deck of the bridge owned by the North Kansas City Development Co. The price is $1,200,000. Both the city and Clay County have made a proposition to the State legislature that the State highway department or the Federal government should undertake any alterations necessary and also the maintenance of the highway. In the fall of 1926 the city voted $1,350,000 in bonds for the purpose of either buying an easement over this bridge or building a new bridge. Supplementing this, Clay County, on the north or opposite side of the river, voted an issue of $150,000, making a total of $1,500,000. After lengthy negotiations, the North Kansas City Development Co. accepted the city's offer of $1,200,000 for the easement over the upper deck of the structure. This bridge, known as the Armour - Swift - Burlington Bridge, is a double-deck structure designed by J. A. L. Waddell and built for the North Kansas City company in 1912, primarily to develop territory on the north side of the river. On the upper deck of the approach spans is a highway and a double-track line for street and interurban electric cars, while the lower deck has two tracks for steam railroads. The channel, however, is crossed by a through-truss span with highway carried by the lower chords. From this fixed span is suspended the railway deck, which can be raised by cables to give a 65-ft. headroom for navigation.

Wisconsin Engineers Postpone Registration Bill

At the recent annual meeting of the Engineering Society of Wisconsin, at Madison, Wis., it was decided not to introduce the proposed bill for the licensing or registration of engineers, but to conduct a campaign for strong support of the bill in 1929, which is the next legislative year. That old street paving should be more generally recognized as a valuable base for new surfacing was urged in a committee report. Elimination of the 30-mile speed limit on highway traffic was urged in a paper by John T. Donaghey, former chief state highway engineer, who cited the Minnesota law as an ideal, with arrests only for reckless driving. Methods of plotting property were discussed by Robert Kingery, Chicago. A session devoted to materials of construction included papers on: "Fatigue of Metals and Concrete," by Professor J. B. Kommers; "Quick Hardening Cement," by R. R. Coghlan, Miami Portland Cement Co.; "High Early Strength Concrete," by J. H. Church, Universal Portland Cement Co., and "Weighing Materials for Concrete Road Construction," by R. W. Crum, Iowa State Highway Commission. Methods of control of pollution of surface waters were discussed by Adolph Kannenberg, of the Wisconsin Railroad Commission. In recognition of his long and active service as secretary of the society, a gold watch was presented to Professor L. S. Smith. Officers for the coming year include: President, G. E. Heebink, city engineer of Beloit; vice-president, J. P. Schwada, city engineer of Milwaukee; secretary, Professor Charles I. Corp, University of Wisconsin, Madison.

Washington Notes

FAILURE of the second deficiency bill to pass Congress before adjournment has a far-reaching effect on the work of the Interior Department. Besides an item of $37,200,000 for war pensions, the bill carried an appropriation of $1,020,991 for the Indian service and the following allotments for Reclamation Bureau projects: Okanogan, $300,000 for a pumping plant; Riverton, $500,000 for continuance of construction; (the failure of this will defer development and delay securing returns from the $3,500,000 already invested in this project); Newlands, $100,000 for Truckee Canal; and Boise, reappropriation of $106,000 for Deadwood storage. There were also included $100,000 for refund of construction charges on permanently unproductive land, and $50,000 for investigation of arid, semi-arid and cut-over lands.

THE Department of State has enquired of the Canadian minister whether the Canadian government would be disposed to join this government in referring the entire problem of the Roseau River drainage system in the interests alike of the people of Minnesota and Manitoba to the International Joint Commission to make an investigation and submit a report and recommendations to the governments. The Department of State also suggests that if the Canadian government would be willing to join the United States in such a reference to the commission it might be desirable for the two governments to designate engineers, one by each government, to confer and submit a draft of the terms of reference.

ADDITIONAL legislation in connection with the division of the waters of the North Platte River has been reported favorably by the House Committee on Irrigation and Reclamation. A letter from the Secretary of the Interior is made a part of the report. In that letter, among other things, he says:

"There has been heretofore created a commission composed of representatives from the states of Colorado, Nebraska, and Wyoming, with a member appointed by the President to represent the United States, whose purpose it is to apportion among the states named the waters of the North Platte River and tributaries. This commission has held several meetings at which considerable testimony has been taken and other work done.

"The bill provides for the appointment by the President of a representative from the Department of the Interior to participate in the negotiations."

Congress Authorizes Columbia and Delaware River Bridges

Acts just passed by Congress and approved by the President give authorization for the construction of new bridges over the Delaware and Columbia Rivers. The Tacony - Palmyra Bridge Co. is authorized to build a toll bridge across the Delaware River from Tacony, in the northern part of Philadelphia, Pa., to Palmyra, N. J., under the terms specified by the standard form of bridge bill developed by the House of Representatives in 1926.

W. D. Comer and Wesley Vandercook are authorized to build a bridge across the Columbia River between Longview, Wash., and Rainier, Ore., for toll operation, under similar terms, with the added feature that the plans must be approved by the Secretary of War, the Secretary of Commerce, and the Secretary of Agriculture acting jointly (instead of by the Secretary of War alone as is provided for all other bridges, under the act of March 23, 1906). The three secretaries are to determine "whether the type, designs and specifications are adequate, based upon the proposed use, volume, and weight of traffic passing over such bridge, and whether the height and clearances of such bridge are adequate to protect the commerce on said Columbia River, and whether the location selected is feasible for the erection of such bridge without obstruction in navigation and without being detrimental to the development of interstate and foreign as well as domestic commerce moving to and from the Pacific Ocean on the Columbia River to the inland waters of the states concerned, and whether public convenience will be served by such bridge as a connecting link between the federal-aid highway systems of the States of Oregon and Washington." Fixing of toll rates, however, is under control of the Secretary of War alone.

Estimate Board Approves McGovern Subway Contract

On March 7 the Board of Estimate and Apportionment of New York City as a committee of the whole approved the recommendation of the Board of Transportation that the contract for the construction of the 53rd St.-Queens subway tunnel be awarded to Patrick McGovern, Inc. The contract price is $10,481,550. There only remains for the Board of Estimate, sitting as a whole body for the public, to approve the award and make the construction appropriation.

U. S. Coast Guard to Appoint Three Constructors

The United States Coast Guard contemplates the appointment of three constructors who will be commissioned officers to perform duty in connection with the construction and repair of vessels and boats. To be considered for the next examination applications must be received at the Coast Guard headquarters not later than April 15. Further information can be obtained upon application to the Commandant, U. S. Coast Guard, Washington, D. C.

Personal Notes

J. W. TURNER, city engineer of Lake Wales, Florida, has resigned and is succeeded by J. S. WHITEHURST, who has been assistant city engineer. Mr. Turner was the first engineer of Lake Wales and constructed many miles of paved streets in the city.

J. V. JOYCE, Kelso, Wash., has been appointed engineer of Pacific County, with headquarters at South Bend.

PHILIP E. BOND has been appointed city engineer of Holyoke, Mass., by the incoming mayor, and succeeds JOHN M. MYERS. Mr. Bond was city engineer during an earlier administration of the new mayor.

MINOR R. TILLOTSON, who has been park engineer at Grand Canyon National Park in Arizona for the past five years, has been made superintendent of the park. Mr. Tillotson is a graduate in civil engineering of Purdue University.

IRA G. HEDRICK, Shreveport, La., announces that the firm of Hedrick & Frost, consulting and construction engineers, has been dissolved and that he has set up a business under the name of Ira G. Hedrick, Inc., consulting engineers, located at 320 Ardis Building, Shreveport, La.

ALBERT T. BROWN, civil engineer, has opened offices at 832-834 Merchants National Bank Building, Los Angeles, Calif., for general engineering practice. Mr. Brown was for the past four years associated with Edward M. Lynch, civil engineer, Los Angeles, and prior to that was engaged in municipal, harbor and irrigation work in Oregon and Washington

G. A. NOREN, designing engineer of the New York Central R.R., Buffalo and East, with headquarters in New York City, has been appointed engineering assistant to the vice-president, with the same headquarters. Mr. Noren had previously served on location on the river crossing of the Hudson River Connecting Ry., as resident engineer for the New York Central at Poughkeepsie, N. Y., as assistant engineer of the Eastern District, and as engineer of grade crossings with headquarters at New York City.

A. R. ACHESON, formerly on engineering work for the public works department of New Zealand, has returned to the United States and is an engineering assistant in the New York State Highway Department; he is located at Syracuse, N. Y.

J. L. ALLISON has recently become associated with H. G. Acres & Co., Ltd., consulting engineers, Niagara Falls, Ontario, as hydraulic engineer. Mr. Allison formerly was hydraulic and designing engineer for Ross & Holgate and for Henry Holgate and prepared plans and supervised construction of many large hydro-electric projects in Canada, including works of the Canadian International Nickel Co. in Ontario, the West Kootenay Power Co. in British Columbia and important installations in the province of Quebec. Later he was designing engineer for Wm. I. Bishop, Ltd., on a large dam in Newfoundland—a plant for the St. Regis Paper Co. in Quebec. More recently Mr. Allison was for eighteen months specially retained as a designing engineer by the Department of Railways and Canals of Ottawa to assist the chairman of the Canadian section of the International Board of Engineers investigating the improvement of the St. Lawrence River for navigation and power.

Engineering Societies

Calendar

Annual Meetings

ASSOCIATED PENNSYLVANIA CONSTRUCTORS, Harrisburg, Pa.; Annual Meeting, Harrisburg, March 24, afternoon, and March 25, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Spring Meeting, Asheville, N. C., April 20-22, 1927.

AMERICAN WELDING SOCIETY, New York; Annual meeting, New York City, April 27-29.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Chicago, Ill., May 9-12, 1927.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Tulsa, Okla., June 6-8, 1927.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Chicago, Ill., June 6 to 11, 1927.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, French Lick, Ind., June 20-24, 1927.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, New York City; Annual Meeting, Orono, Maine, June 27-30, 1927.

The Russian Association of Engineers (headquarters 186 Liberty St., New York City) at a meeting March 31 in the Engineering Societies Building, 29 West 39th St., New York City, will have an address by Howard W Dunbar, assistant general sales manager of the Norton Co., on "Some High Light in Grinding" with a comparison of machine operation twenty-five years ago and now.

The Brooklyn Engineers' Club at its March 10 meeting is to be given an address by Past-President Frank W. Skinner on the "Unlimited Potential Durability of Structural Steel."

The Little Rock, Ark., Engineers' Club recently elected R. C. Limerick, former state highway engineer, president; Ellis Ford, of Ford & McCrea, vice-president; and Robert Warren, purchasing agent of the Arkansas Power & Light Co., secretary-treasurer.

The American Association of Engineers will hold its annual convention at Tulsa, Okla., June 6 to 8, and at the same time the **Oklahoma Division** of the society will hold its annual meeting.

Obituary

JOHN DE HART, architect and civil engineer, New York City, died Feb. 17 of heart disease at the age of 64. He was a member of the Board of Standards and Appeals for three years and was a designer of dwellings.

MORRIS F. LEVY, head of the Levy Construction Co., and president of the Denver Allied Contractors' Association, died Feb. 17 after a brief illness, aged 44 years. Mr. Levy received his engineering education at the Washington University, went to Denver twenty-five years ago and engaged in the bridge department of the Denver & Rio Grande Railroad Co.

GEORGE A. MOUNTAIN, Ottawa, Ontario, formerly chief engineer of the Board of Railway Commissioners of Canada, died Feb. 26 at Ottawa, in his 67th year. Mr. Mountain was chief engineer of the Board of Railway Commissioners from 1904 to 1924 when he retired. Prior to 1904 he was for many years associated with the old Canada Atlantic Ry., having joined that staff in 1881, and later became its chief engineer. He was a past president of the Engineering Institute of Canada.

CARL LEONARDT, of Los Angeles, Calif., president of the Southwestern Portland Cement Co., died Feb. 14 after an operation in a hospital in Los Angeles, aged 71 years. Mr. Leonardt was born in Westphalia, Germany, and came to America about 1886, going to Los Angeles the following year. For a long time he was a building contractor and erected many well-known buildings in Coast cities. About eight years ago he became interested in the cement business and later became president of the Southwestern Portland Cement Co., devoting himself exclusively to his cement plant interests, operating mills at Victorville, Calif., El Paso, Texas, and Dayton, Ohio.

JAMES OLIVER, contractor, Yonkers, N. Y., who built the Belmont Park race track, some sections of the Wabash railroad, the Yonkers street railway, the race track at Saratoga, N. Y., and other works, died Feb. 27 at his home in Yonkers.

EDWARD Y. BUCHANAN, Oakland, Calif., retired civil engineer, died Feb. 28, aged 84 years. Mr. Buchanan did surveying work after the Civil War on the Union Pacific R.R. and on the Southern Pacific line to Coos Bay, Ore.

SETH DEAN, Glenwood, Iowa, civil engineer and surveyor of Mills County, Iowa, for many years until he retired in 1924, died Feb. 14 at his home in Glenwood, aged 75 years. Beside his long service as county surveyor, Mr. Dean was consulted in drainage engineering in the establishment of drainage districts in the state of Iowa. His son, Seth Dean, states that in his father's library are complete files of *Engineering News-Record* and *Engineering News* and its predecessors back to Vol. 1, No. 1, of the *Architect and Surveyor* of 1874.

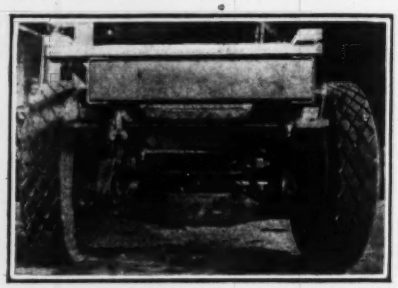
Construction Equipment and Materials

A Section Devoted to What the Manufacturer is Doing for the Engineer and Contractor

Motor Truck Has New Form of Axle Drive

A new form of drive involving two rear axles—a floating live axle and a fixed wheel axle—is the main feature of the motor truck recently announced by the Relay Motors Corp., Wabash, Ind., a new organization resulting from a consolidation of the Commerce Motor Truck Co. and Service Motors, Inc. The truck is being made in 2½ and 3½ ton sizes but will later include models from 1 to 7 tons.

In other standard makes of trucks the load is carried by the rear axle and bears on the road directly underneath. With the new Relay axle drive, however, the load is carried on the live axle which is below the wheel axle and is free to swing about the wheel axle



LOAD CARRIED ON LIVE AXLE
UNDERNEATH WHEEL AXLE

as a center. At each end of the live axle is a pinion, shown in one of the photographs, which engages a circular gear track fixed to each of the rear wheels. When power is applied to the live axle, the drive pinions climb up the circular track and in so doing lift the chassis and load forward and upward so that the weight thus displaced acts downward through the circular gear track to rotate the wheels.

PINION AND CIRCULAR GEAR
TRACK DRIVE

For purposes of illustration, the action of the drive may be described as similar to that of a large barrel with a man inside of it; as the man walks up the inside surface his weight starts the barrel rolling forward.

In actual operation, the drive pinions of the truck can climb up the circular track to a position where the truck and its load have moved forward or backward 6½ in. with reference to the rear wheels, during which movement the rear end of the truck and its load is raised 5¼ in. In other words, the pinions can swing through an arc of 120 deg. The engine, therefore, is steadily working to raise the weight of the load, and the weight is constantly acting downward in a manner to cause the rear wheels to rotate.

It is claimed by the manufacturer of the truck that superior tractive effort is produced by the new drive, since the weight of the load is always carried at a point forward of the point of contact between wheels and road. Another advantage, according to the manufacturer of the truck, is reduced wear on the tires due to their being laid on the ground rather than pushed against it. The rear axle design also is said to have a cushioning effect which lengthens the life of the truck unit.

The relay truck is said to be particularly adapted to conditions in the engineering-construction field where steep grades are commonly encountered and where haulage must be done over poor roads and through sand and soft earth, demanding tractive power sufficient to prevent a truck from being mired or stalled.

New Single Reduction Gear Units

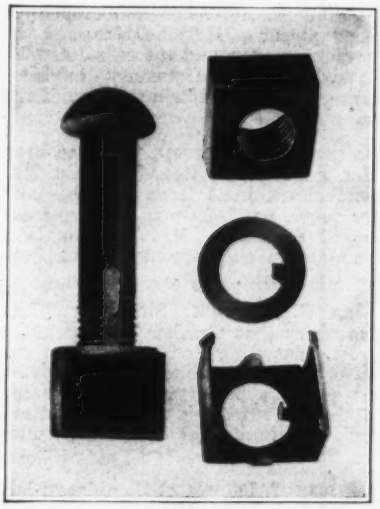
A series of reduction gear units for heavy service has been developed by R. D. Nuttall Co., Pittsburgh, Pa. There are six units in the series, which covers a range of from 150 to 2,000 hp. They are designed for services that require transmitting heavy loads at relatively high speeds, such as main and auxiliary drives in steel mills, the driving of crushers, hoists, pumps, and other similar heavy equipment.

The units are equipped with either the company's 7½ single helical or herringbone gears, treated or untreated, depending on application. They are furnished as desired with either sleeve or Timken tapered roller bearings. It is possible to replace one type of bearing with the other because the bearing housings are identical in both types. However, in case of a change new shafts would have to be provided.

The gears are totally inclosed in a cast-iron case fabricated to lessen the weight. Thus, they are carefully protected from grit and dirt. The bottom of the case serves as a reservoir for lubricant and the gears run in a bath of oil. The bearings are lubricated by a positive splash system. The same lubricant is used for both gears and bearings.

Track Lock-Nut Provides Safety and Reduces Maintenance

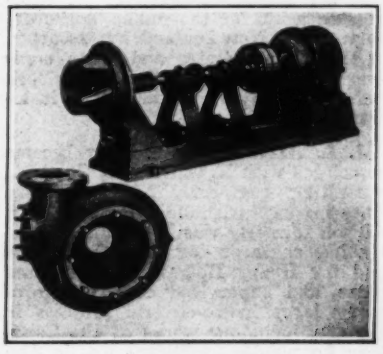
The illustration shows an improvement in a specially designed lock nut for use in crossings, switches and guard rails and adaptable to general track installation through the addition of a high pressure spring washer. It is claimed that it is impossible for the



nuts to work loose and they thus provide safe joints which will operate many years without any maintenance. The Andrix Lock-Nut Co., Adrian, Mich., manufacturer of the nut, states that the Wabash Railway Co. has made this lock nut standard on that road. The lock is made both square and hexagonal to fit standard nuts.

Non-Clogging Centrifugal Pump Eliminates Screening

It is necessary in many cases to screen fluids containing debris before they can be pumped. The American Well Works, Aurora, Ill., has just developed a non-clogging centrifugal pump which is claimed to eliminate the necessity of screens and their expensive maintenance. The single-blade impeller in the pump is so designed that stream lines are not separated. The fluid is



thus kept in one mass as it is carried through the pump. Thus, by discharging all of the liquid and debris through a single peripheral passage, it is claimed that the possibility of debris being caught in the impeller is avoided. The pump is made in both vertical and horizontal types and is adapted for municipal sewage and general industrial work.

Electric Heat Helps Thermit Welding

Electric heat has now been applied in connection with thermit welding. The Metal & Thermit Corporation, of Jersey City, N. J., has introduced General Electric heating units on its track-welding equipments for the purpose of assisting the vaporization of the kerosene oil which is used for preheating the work. The oil is passed through the heating unit and is then mixed with compressed air at a pressure of approximately one pound, after which it passes through a rubber hose to the torch used in applying the heat to the rails. In addition, the heating unit acts as a resistor. The equipment is electrically operated from the standard 550/600-volt trolley circuit, and the group of two heating units is connected in series and placed in series with the 230-volt, direct-current motor which drives the compressor. With this arrangement a snap switch can be used to start the motor, as the heating units have sufficient resistance to hold back the in-rush of current until the motor comes up to speed.

Welding Used in Making Welding Machine

Among the developments in the machinery-building field is the substitution of welded structural steel in place of gray-iron castings. This is illustrated in the new 300-amp. a.c. welding machine of the Lincoln Electric Co., of Cleveland, Ohio. This outfit has only two gray-iron castings, weighing about 15 lb. in all, which have not been replaced with welded-steel construction. Other sizes and types of welders are being changed over to the steel construction as rapidly as possible. The motor and generator end rings, brackets, and connecting rings are all made of structural angles rolled up into the proper shape and welded together. The feet of the motor generator set are made of drop forgings. Truck wheels are made of T-sections rolled on a special machine. The hub of the wheel is made of steel tube. Control panels are usually made of slate or special non-metallic compounds, but the panel illustrated is made of sheet steel welded together and welded to the supports.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL BATTERY MANUFACTURERS' ASSOCIATION, New York; Annual meeting, Philadelphia, March 11 and 12, 1927.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; Annual Meeting, White Sulphur Springs, West Va., March 21-23.

SOUTHERN PINE ASSOCIATION; New Orleans; Annual meeting, New Orleans, March 22-23.

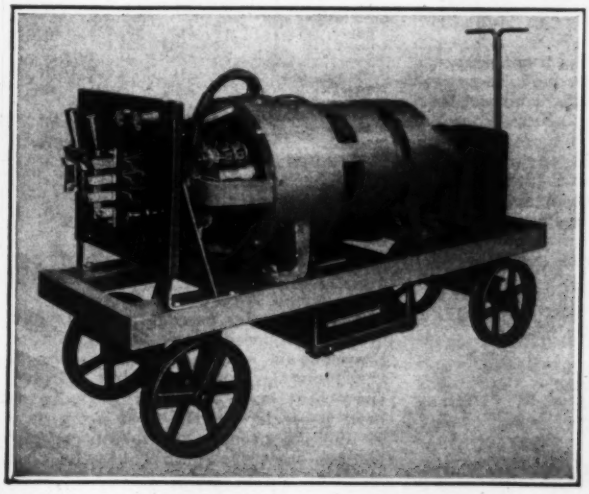
HYDRAULIC SOCIETY, New York; Annual meeting Chicago, March 25, 1927.

WATERWORKS MANUFACTURERS ASSOCIATION, New York; Annual meeting, Chicago, June 6-10.

Portable Electric Hand Saw Will Cut Numerous Materials

The portable electric hand saw shown in the accompanying illustration is being manufactured by the Wappat Gear Works, Pittsburgh, Pa., for use on construction jobs and in industrial plants. The saw cross-cuts and rips boards up to and including 3 in. in thickness.

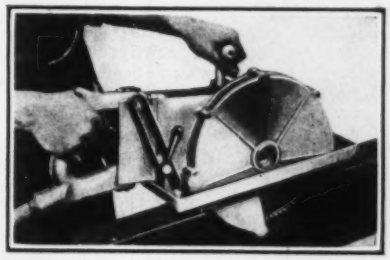
Special saw blades can be furnished for cutting wood, fibre, bakelite, hard rubber, stone, steel and many other materials.



Five saw blades are furnished. Two 8-in. and one 9-in. saw, for cross-cutting and occasional ripping; one 8-in., one 9-in. rip saw.

The saw is equipped with a motor rated at ¾ hp. and mounted upon Timken tapered roller bearings. The motor will use either a.c. or d.c. Regular equipment includes 15 ft. of heavy-duty rubber-covered wire and an armoured attachment plug.

A particular feature of this device is a telescoping guard that completely incloses the blade and automatically opens only when the saw is pushed into the material. It closes again as soon as the cut is completed. This guard affords maximum safety against accident and protects the blade from dam-



age as well. A wide carrying shoe supports the weight of the tool and prevents tipping, so that the chief effort of the operator is in guiding the saw. This shoe is made of pressed steel and is nickel plated. It is adjustable so that it is possible to set the saw for any depth of cut such as would be required when cutting out sections of flooring and the like. The presence of this shoe insures square cuts and prevents straining the saw blade, thus eliminating the danger of broken blades.

A blast of air from the motor ventilating fan is directed to the front of the saw to blow the sawdust away. The handles of the device are placed to give good balance and to eliminate wrist strain. The total weight of the outfit is 31 pounds.

Railroad Spraying Device Reaches Two Parallel Tracks

A miniature model of a spraying device for the distribution of weed exterminator is being exhibited at the Railway Show by the Reade Mfg. Co., Jersey City, N. J. The device is ar-

READE SPRAYING DEVICE

ranged so that two parallel tracks can be sprayed at the same time in one forward movement, thus eliminating practically half the movement required for treating such tracks with former models of such spraying equipment.

Business Notes

BLAW-KNOX CO. announces an addition to its engineering and selling staff in the person of John C. White, president of the Arrowhead Iron Works of Pennsylvania, Inc. Mr. White has recently been appointed sales manager of the steel grating and flooring depart-

ment. He will be located at the general offices of the Blaw-Knox Co. at Pittsburgh.

CHARLES JOHNSTON has resigned from the steel construction department of the Jones & Laughlin Steel Corporation to go with the Berger Mfg. Co. as sales manager in the Philadelphia district. Prior to joining the Jones & Laughlin organization he served as captain of infantry with the A.E.F., and for ten years had been with the General Fireproofing Co. of Youngstown, O. While with Jones & Laughlin he was actively engaged in the development of the junior beam.

BRICK ORDERS totaling 10,000,000 brick are reported to have been made by Fred F. French Co., New York City, for use on its so-called Tudor City apartment project, which is planned to extend from 40th to 44th Streets and from First to Second Avenues, New York. This is said to be the largest order of bricks for facing purposes ever placed in New York City. This brick is to come from the south in ocean-going barges. The Fish Clay Products Co. are reported to have received the order.

J. K. HAIGH has been appointed Los Angeles branch manager of The Rix Co., compressed air engineers, whose main office and factory is located in San Francisco.

New Publications

Nickel Steel—INTERNATIONAL NICKEL CO., New York City, has prepared in folder form nine of its publications on the data and applications of nickel steel. The information is reprinted from publications of such sources as the Bureau of Standards, the American Society for Steel Treating, *Iron Age*, and Army Ordnances. The nine bulletins treat the following subjects: S.A.E. standard specifications for steel; physical and mechanical properties of nickel steel; treatment and applications of nickel and nickel chromium steel; making steel castings stronger; mill inspection of steel; alloy steel reduces die block cost; automobile design and automotive steel; improving gray cast iron with nickel; and physical properties of nickel and nickel chromium steel.

Manhole Covers—BROWN & BROWN, Lima, Ohio, has issued a pamphlet describing its locking manhole covers, flush tank valves, and cast iron manhole steps. Detailed drawings and illustrations support the descriptive text.

Fans and Blowers—AMERICAN BLOWER CO., in Bulletin 8001, illustrates and describes its fans and blowers. The catalog is mostly a compliation of capacity tables, to which about fifty of the seventy pages are devoted. The remaining part of the book is devoted to cuts, illustrations and dimensional tables.

Business Side of Construction

Facts and Events that Affect Cost and Volume

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings. Under the head of excavations are included drainage, irrigation, levee, river and harbor projects.

Money Value of Contracts Let—Entire U. S.

Week Ending	Public Work	Private Work	Total Contracts
Mar. 10, 1927	$27,407,000	$54,796,000	$82,203,000
Mar. 3, 1927	14,917,000	33,764,000	48,681,000
Mar. 11, 1926	13,029,000	73,613,000	86,642,000
Heaviest Week			
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
Jan. 1 to Date			
1927	150,213,000	337,529,000	487,742,000
1926	161,326,000	350,462,000	511,788,000

Projected Work Indicates No Recession in Big Building Construction

Apartments and Hotels Lead Commercial Group in Number While Automotive and Public Utilities Head Industrial

A VERY favorable outlook, so far as the nation's commercial and industrial building programs are concerned, is gained from the examination of proposed projects, definitely reported in *Engineering News-Record* during the first two months of 1927.

The figures accompanying are based on projects valued at $150,000 and up for commercial, educational, religious, institutional, public buildings, etc., and $40,000 minimum on structures of a strictly manufacturing or industrial nature.

Assuming that half of these proposed jobs are due to fall through, there will still be left a two-months' contract total for both classes, substantially ahead of that for the first two months of this year and also well in advance of the corresponding period in 1926.

Based on the minimum mentioned in each class, the following figures (Table I) for the entire U. S., compare the situation this year, with last:

TABLE I—CONTRACTS AWARDED AND WORK PROPOSED IN FIRST TWO MONTHS OF THIS YEAR AND LAST

	1927 Number	1927 Value (000 Omitted)	1926 Number	1926 Value (000 Omitted)
Commercial Buildings				
Contracts	459	$237,618	370	$196,063
Proposed	1,127	625,630	984	503,059
Industrial Buildings				
Contracts	189	$31,131	164	$57,472
Proposed	270	128,241	257	88,294

The following (Table II) compares number and value of commercial and related building contracts awarded in the United States during January and February of this year and last:

TABLE II—COMMERCIAL BUILDING CONTRACTS AWARDED IN U. S. DURING FIRST TWO MONTHS OF 1926 AND 1927

	Number 1926	Number 1927	Value (000 Omitted) 1926	Value (000 Omitted) 1927
Apartments and hotels	108	143	$55,623	$66,347
Schools	78	64	25,207	23,229
Offices	60	122	64,074	82,356
Hospitals	20	31	8,334	17,531
Stores	6	...	1,567	.....
Warehouses and lofts	12	8	9,131	2,666
Theatres	13	31	4,090	20,254
Churches	17	33	7,334	8,621
Lodges, halls and clubs	16	13	4,420	4,755
Public buildings	11	14	5,975	11,859
Garages	16	...	5,980	.....
Banks	7	...	1,485	.....
Exchanges	4	...	993	.....
Depots and stations	2	...	1,850	.....
Total	370	459	$196,063	$237,618
Average contract	...	...	$530	$518

Following the assumption that half of this proposed work will not reach the contract stage, an examination of the money values in Table III will show that sufficient work has already been projected in the first sixty days of 1927 to produce a substantial gain in each class shown in Table II.

(*Continued on p. 429*)

(Continued from p. 428)

TABLE III—COMMERCIAL BUILDINGS PROPOSED IN JAN. AND FEB., 1927

	Number	Value
Apartments and hotels	266	$153,650,000
Business	225	198,695,000
Schools	221	82,967,000
Hospitals	99	51,532,000
Warehouses	31	24,480,000
Theatres	69	23,665,000
Churches	90	21,865,000
Lodges, halls and clubs	71	42,506,000
Public buildings	55	26,270,000
Total	1,127	$625,630,000

In table IV are shown number and value of industrial building contracts awarded during the first two months of this year and last, at the minimum mentioned.

TABLE IV—INDUSTRIAL BUILDING CONTRACTS

	Number		Value (000 Omitted)	
	1926	1927	1926	1927
Public utilities	15	15	$23,658	$11,443
Chemical process	10	15	4,220	1,134
Food products	20	21	3,075	2,540
Automobiles	24	30	6,850	2,313
Machinery and equipment	34	34	4,588	4,667
Textile and clothing	13	12	2,492	1,028
Printing and binding	5	7	687	1,310
Steel mills	3	2	2,090	310
Cement and quarry products	6	5	5,294	315
Foundries	7	3	527	893
Refrigeration and cold storage	9	16	1,040	1,448
Lumber and woodworking	6	3	2,450	545
Unclassified	12	17	896	1,825
Warehouses	..	9	.....	1,360
Total	164	189	$57,867	$31,131
Average contract	...	...	$353	$165

Engineering News-Record

Construction Costs

As promised last week, the table of contents of Engineering News-Record's new compilation of materials prices, labor rates, etc., from 1910 through 1926 is here given.

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Supplement

UNIT BIDS ON FIFTY TYPICAL JOBS OF 1926 ..... 24 to 48

One dollar per copy, postpaid. You may send cash at our risk.

Construction News Editor
Engineering News-Record
Tenth Ave. at 36th Street,
New York, N. Y.

TABLE V—COMMERCIAL BUILDING PROJECTS BY STATES
Buildings to Cost $150,000 and More Proposed in Jan. and Feb., 1927

	Number	Value		Number	Value
Me	14	$2,455,000	Ohio	67	$26,825,000
N. H	9	1,400,000	Ind	48	8,031,000
Vt	7	1,050,000	Ill	65	83,925,000
Mass	185	44,185,000	Wisc	44	19,690,000
R. I	29	7,775,000	Mich	39	36,750,000
Conn	47	12,219,000			
			Total	263	$175,221,000
Total	291	$69,084,000	Minn	16	$6,175,000
N. Y	147	$132,441,000	Iowa	10	5,350,000
N. J	26	39,080,000	Mo	39	21,090,000
Penn	53	31,800,000	Ark	6	2,091,000
Md	20	16,715,000	N. D	...	.....
Del	...	.....	S. D	2	900,000
			Neb	3	1,650,000
Total	246	$220,036,000	Kan	10	3,300,000
Va	3	$3,300,000	Okla	18	8,985,000
W. Va	...	.....	Tex	61	30,563,000
N. C	6	3,400,000	Mont	...	.....
S. C	...	.....	Wyo	...	.....
Ga	4	755,000	Colo	...	.....
Fla	5	3,685,000	N. Mex	2	350,000
Ala	2	650,000			
Miss	2	950,000	Total	167	$80,454,000
La	8	3,400,000	Idaho	...	.....
Ky	3	1,550,000	Utah	...	.....
Tenn	11	7,475,000	Ariz	...	.....
			Nev	...	.....
Total	44	$25,165,000	Wash	10	$8,250,000
			Ore	12	5,335,000
			Calif	111	42,085,000
			Total	133	$55,670,000
			Grand total	1,127	$625,630,000

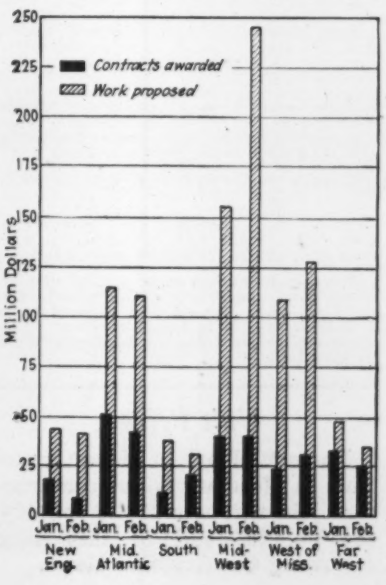
TABLE VI—INDUSTRIAL BUILDING PROJECTS BY STATES
Buildings to Cost $40,000 and More Proposed in Jan. and Feb., 1927

	Number	Value		Number	Value
Me	1	$200,000	Ohio	23	$20,460,000
N. H	2	105,000	Ind	11	3,175,000
Vt	1	40,000	Ill	9	22,005,000
Mass	29	1,450,000	Wisc	15	875,000
R. I	2	200,000	Mich	2	350,000
Conn	16	2,100,000			
			Total	60	$46,865,000
Total	51	$4,095,000	Minn	4	$420,000
N. Y	24	$7,730,000	Iowa	2	565,000
N. J	4	875,000	Mo	14	2,055,000
Penn	14	1,450,000	Ark	5	9,475,000
Md	2	2,100,000	N. D	...	.....
Del	...	.....	S. D	1	250,000
			Neb	4	756,000
Total	44	$12,155,000	Kan	1	375,000
Va	8	$7,090,000	Okla	11	3,570,000
W. Va	1	200,000	Tex	31	21,945,000
N. C	2	350,000	Mont	...	.....
S. C	...	.....	Wyo	...	.....
Ga	...	.....	Colo	2	90,000
Fla	...	.....			
Ala	1	200,000	Total	75	$39,501,000
Miss	1	100,000	Idaho	...	.....
La	...	.....	Utah	...	.....
Ky	1	250,000	Ariz	...	.....
Tenn	4	2,850,000	Nev	...	.....
			Wash	5	$11,640,000
Total	18	$11,040,000	Ore	...	.....
			Calif	17	2,945,000
			Total	22	$14,585,000
			Grand total	270	$128,241,000

Trend of Construction Demand in Various Sections of U. S.

The accompanying diagram shows the relation of proposed projects to contracts already let on large engineering construction work throughout the country. The comparisons are between January and February of the current year in the various sections. See table of week's contracts on p. 428 for minimum values.

The first three geographic divisions are familiar to all. The last three, however, may be defined as follows: Middle West—Ohio, Indiana, Michigan, Illinois, Wisconsin. West of Mississippi—Arkansas, Colorado, Iowa, Kansas, Minnesota, Montana, Missouri, New Mexico, North Dakota, Nebraska, Oklahoma, South Dakota, Texas, Wyoming. Far West — Idaho, Utah, Nevada, Arizona, Washington, Oregon, California. Where the total of proposed work is highest, there the contract volume may be expected to increase, proportionately.



Weekly Construction Market

CONSISTENT with the increasing firmness in the general wholesale market, prices of construction materials show an excess of advances over declines as the regular spring building demand begins to make itself felt. The foregoing is, of course, an opinion based on current developments in the nine great industrial districts included in the accompanying table.

Important price movements, that have taken place since this tabulation last appeared, affect tile, along the Eastern seaboard and cast-iron pipe and lumber, in the West. Linseed oil declined sharply at New York, Atlanta, Chicago, and Denver, but remained unchanged in the Minneapolis market. Western tile prices have not yet taken on the firmness apparent in the other producing centers of the country.

Demand for materials and equipment, as indicated by contracts awarded on large engineering construction jobs, shows a gain of 2 per cent in privately owned projects, over that for the period Jan. 1 to March 3, last year. A decline of about 17 per cent in public work, however, leaves a net loss of slightly over 4 per cent, when total money value of contracts let during the first nine weeks of 1927 is compared with that for the corresponding part of last year. Average costs, for the January-March period, are 1.4 per cent above the level for the same months in 1926.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.80	$4.15	$3.10	$3.35	$3.87½	$3.00	$3.15	$3.80
Structural rivets, 100 lb.	4.20	3.80	4.75	3.50	3.75	4.65	5.00	4.00	....
Reinforcing bars, ¾ in. up, 100 lb.	3.24	2.80	2.75	2.30@2.50	2.87½	3.87½	2.95	3.10	3.57
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	54%	51%	54.25%	41%	42@53.8%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	47.60	42.75	56.00	+46.20	48.50	62.00	47.00	55.00	62.50
Concreting Material									
Cement without bags, bbl.	2.35@2.50	2.35	2.05	2.05	2.22	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	1.85	1.65	1.90	1.80	1.25	1.90
Sand, cu.yd.	1.00	1.60	2.00	1.65	1.25	1.00	1.40	1.25	1.35
Crushed stone, ¾ in., cu.yd.	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	61@63	34.00	56.00	+40.50	39.25	33.25	27.00	25.00	50.00
Lime, finishing, hydrated, ton	18.20	23.50	19.00	20.00	25.50	24.00	25.50	24.00	21.00
Lime, common, lump, per bbl.	2.10@3.00	1.50	1.82	1.50	1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	20.40@22.40	10.50	14.10	12.00	13.75	9@10	15.00	15.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	.076	—.072	.085	.....	.09	.10
Hollow partition tile 4x12x12, per block	+.1112	.0895	.112	.076	—.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	—.81¾	—.90	1.10	—.80	.93¾	—1.04	.91	1.12	1.03
Common Labor									
Common labor, union, hour	.90½	.30	.....	.90	.....	.50@.55	.60	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.....	.45@.60	.40@.45	50	.....	25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.
Labor — Cement and concrete laborers' rate, $1.06¼; building laborers, 90½c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Mar. 3, the next on Apr. 7.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) carlots; shapes, l.c.l.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) and shapes, less-than-carload lots.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 99.81). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) and shapes, in carload lots.

Unit Prices

For actual prices bid on materials in place at various construction jobs throughout the country, see pp. 162-162A of this issue following Construction News.

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For Explanation and Details of Indexes Since 1913
See the First Issue of Every Month